DOCUMENT RESUME

ED 479 030 IR 022 006

AUTHOR	Strohlein, Georg; Fritsch, Helmut
TITLE	Test and Evaluation of a Course Designed for Mobile Learning. ZIFF Papiere.
INSTITUTION	Fern Univ., Hagen (Germany). Inst. for Research into Distance Education.
SPONS AGENCY	European Union, Brussels (Belgium).
REPORT NO	ZIFF-120
ISSN	ISSN-1435-9340
PUB DATE	2003-03-00
NOTE	83p.; Some figures contain very small and illegible font.
AVAILABLE FROM	FernUniversitat, ZIFF, Postfach 940, D - 58084 Hagen, Germany. Fax: 49 2331 880637; Web site: http://www.fernuni-hagen.de/ZIFF. For full text: http://www.fernuni-hagen.de/ZIFF/ZIFF_PAP_120.pdf/ .
PUB TYPE	Reports - Research (143)
EDRS PRICE	EDRS Price MF01/PC04 Plus Postage.
DESCRIPTORS	Courseware; *Distance Education; *Educational Technology; Instructional Design; Postsecondary Education; *Technology Uses in Education; *Telephone Communications Systems; Web Based Instruction; World Wide Web
IDENTIFIERS	*Course Development; Personal Digital Assistants; Wireless Technology

ABSTRACT

This report contains two parts: "Part I: Design and Implementation" (Georg Strohlein) and "Part II: Student Usage" (Helmut Fritsch). Part I describes the development and practical use of a short course on descriptive statistics designed for mobile learning (i.e., the situation when the learning person is mobile and utilizes mobile devices for the process of learning). During the first phase of the project, the course was developed and basic student support services were designed. The course and the services were implemented on a Web server for access by mobile devices like the smartphone ERICSSON R380s. This version of the course was tried out with several people, and it was concluded that smartphones are not suitable for mobile learning. In the second project phase, the courseware and pages related to student services were transformed into other document formats for use on PDAs (Personal Digital Assistants). Several problems were found with this approach. Part II reports on research that examined the limits of wireless communication devices for teaching and learning. Characteristics of mobile learning, courseware considerations, and redundancy issues are covered. Results of the empirical study are then presented, including social data, user friendliness, didactic efficiency, technical feasibility, and cost effectiveness. (Contains 13 references, 21 charts, and numerous figures.) (MES)

Reproductions supplied by EDRS are the best that can be made
from the original document.

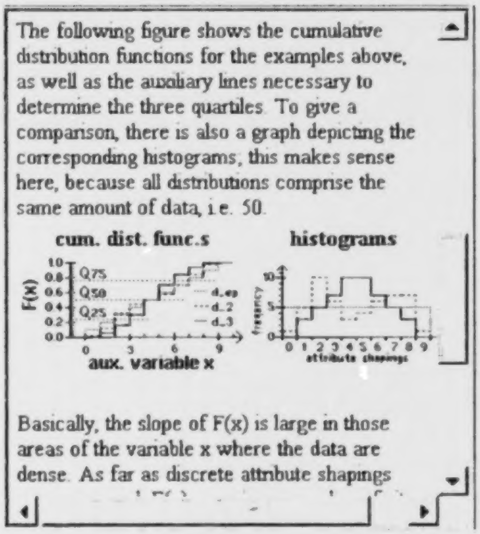
ED 479 030

FernUniversität in Hagen

ZIFF PAPIERE 120

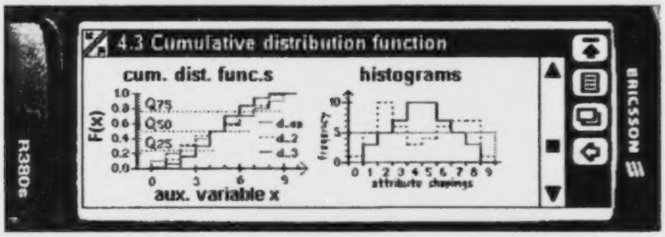
Test and Evaluation of a Course Designed for Mobile Learning

Georg Ströhlein, Part I: Design and Implementation
Helmut Fritsch, Part II: Student Usage


The following figure shows the cumulative distribution functions for the examples above, as well as the auxiliary lines necessary to determine the three quartiles. To give a comparison, there is also a graph depicting the corresponding histograms; this makes sense here, because all distributions comprise the same amount of data, i.e. 50.

cum. dist. func.s
histograms
F(x)
1.0
0.8
0.6
0.4
0.2
0.0
Q75
Q50
Q25
d_eq
d_2
d_3
0
3
6
9
aux. variable x
frequency
10
5
0
0 1 2 3 4 5 6 7 8 9
attribute shapings

Basically, the slope of F(x) is large in those areas of the variable x where the data are dense. As far as discrete attribute shapings


R380s
4.3 Cumulative distribution function
cum. dist. func.s
histograms
F(x)
1.0
0.8
0.6
0.4
0.2
0.0
Q75
Q50
Q25
d_eq
d_2
d_3
0
3
6
9
aux. variable x
frequency
10
5
0
0 1 2 3 4 5 6 7 8 9
attribute shapings
ERICSSON

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL HAS
BEEN GRANTED BY

H. Fritsch

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Zentrales Institut für Fernstudienforschung
FernUniversität in Hagen
März 2003

THIS STUDY WAS SUPPORTED BY THE LEONARDO DA VINCI PROGRAMME OF THE EUROPEAN UNION.

Title graphics: page of course as seen on a PDA (HTML) and a smartphone R380s (WML)

ZIFF PAPIERE ISSN 1435-9340

Herausgegeben von Helmut Fritsch

Redaktion: Frank Doerfert, Helmut Fritsch (beide ZIFF) und Helmut Lehner (Konstanz)

© 2003 Zentrales Institut für Fernstudienforschung (ZIFF), FernUniversität in Hagen

Humpertstr. 11a, D-58084 Hagen
Fon: +49 23 31 – 987 – 2592 Fax: +49 23 31 – 88 06 37
Email: helmut.fritsch@fernuni-hagen.de

PART I, Georg Ströhlein: Design and Implementation

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Characteristics of electronic resp. mobile learning 2

1.2 Presentation of scientific material 2

1.3 The smartphone R380s 5
1.3.1 The appearance of the R380s 5
1.3.2 The built-in software of the R380s 5
1.3.3 The PDA features of the R380s 6

1.4 Summary 9

2 IT-ENVIRONMENT FOR MOBILE LEARNERS 9

2.1 The server side 10
2.1.1 Providing mobile access to the course content 10
2.1.2 Creating content formatted in WML(S)/WBMP 10
2.1.3 Converting content from WML to HTML 22
2.1.4 Converting content from HTML to eBook formats 24

2.2 Providing mobile student support services 28
2.2.1 SMS messages 28
2.2.2 Administration services 29
2.2.3 Tutoring services 33
2.2.4 Communication services 34
2.2.5 Self-examination services 34

2.3 The client side 34
2.3.1 Smartphone ERICSSON R380s 35
2.3.2 CASIO Cassiopeia E-200G together with NOKIA 6310i 37
2.3.3 PSION 5mxPRO together with NOKIA 6310i 38
2.3.4 PALM m515 together with NOKIA 6310i 39

2.4 Summary 39

3 MOBILE LEARNING IN PRACTICE 41
3.1.1 Smartphone R380s 43
3.1.2 CASIO Cassiopeia E-200G 44
3.1.3 PSION 5mxPRO 46
3.1.4 PALM m515 48

3.2 Summary 49

4 COST OF MOBILE LEARNING 49

5 RESUME 51

6 APPENDICES 53

6.1 Addresses of courseware on the web and sample pages 53

6.2 Acknowledgements 61

6.3 Permissions 61
6.3.1 www.ebookmall.com 61
6.3.2 www.thozie.de 61

7 LITERATURE 62

PART I, Georg Ströhlein: Design and Implementation

LIST OF FIGURES

Figure 1-0: Communication channels in mobile learning 2
Figure 1-1: The R380s in telephony-mode 5
Figure 1-2: The R380s in PDA-mode 5
Figure 1-3: Synchronisation error message 6
Figure 1-4: Defining a contact in Lotus Organizer 5.1 7
Figure 1-5: Defining a contact on the R380s 8
Figure 2-1: Example in HTML 11
Figure 2-2: WML(S) page as displayed in ERICSSON IDE 3.11 12
Figure 2-3: WML(S) page as displayed in NOKIA WIT 3.00 13
Figure 2-4: Size and scaling of two R380s emulators 15
Figure 2-5: Layout of WML page 16
Figure 2-6: Line breaks and punctuation marks in WML 17
Figure 2-7: Cyrillic alphabet in WML 18
Figure 2-8: German alphabet in WML 19
Figure 2-9: How text output in MS-Windows depends on pixel height 20
Figure 2-10: Chart with 5 pixel font manually optimised 21
Figure 2-11: Preparing graphic course material 21
Figure 2-12: Small-multiple kind of graphics on the R380s (IDE 3.11 browser) 22
Figure 2-13: Layout of courseware on different devices 24
Figure 2-14: Creation of a ReaderWorks project 26
Figure 2-15: Steps to create an eBook 27
Figure 2-16: Adding personal remarks to an eBook 28
Figure 2-17: Mobile registration procedure 30
Figure 2-18: The tutoring services from student to tutor 33
Figure 2-19: Configuration procedure to define a new WAP profile 36
Figure 2-20: Configuration procedure to define a new WAP service provider 36
Figure 2-21: Configuration procedure to define a new WAP bookmark 37
Figure 3-1: STAT course in HTML 42
Figure 3-2: Some WAP error messages or failures 43
Figure 3-3: R380s in use for mobile learning 44
Figure 3-4: Courseware as displayed on the CASIO E-200G 44
Figure 3-5: E-200G in use for mobile learning 45
Figure 3-6: E-200G in use for mobile learning II 46
Figure 3-7: Courseware as displayed on the PSION 5mxPRO 47
Figure 3-8: Effect of zooming the display on the PSION 5mx PRO 47
Figure 3-9: Courseware as displayed on the Palm m515 48

LIST OF TABLES

Table 1: Recommendations on document formats on various computer platforms 3
Table 2: Comparison of eBook formats on various computer platforms 4
Table 3: T-D1 GPRS tariffs 50
Table 4: Monthly cost of mobile learning for an average 'power user' 50
Table 5: Monthly cost of mobile learning for an average 'home user' 51

PART II, Helmut Fritsch: Student Usage

TABLE OF CONTENTS

1 INTRODUCTION 64

2 MOBILE LEARNING 64

2.1 Characteristics of mobile learning 65

2.2 Considerations about the courseware 65

2.3 Reduction of Redundancy 66

3 RESULTS OF THE EMPIRICAL STUDY 68

3.1 Section 1: social data 68

3.2 Section 2: User friendliness 69

3.3 Section 3: Didactic efficiency 71

3.4 Section 4: Technical feasibility 73

3.5 Section 5: Cost effectiveness 75

4 SUMMARY 76

1 Introduction

This report describes the development and practical use of a short course on descriptive statistics designed for mobile learning. The term 'mobile learning' is used to characterise the situation when the learning person is mobile and utilises mobile devices for the process of learning. Usually, this applies to a situation when the learning person is not sitting at the desk at home, in the office or in an educational institution.

The process of learning isn't completely understood even today, but is very likely to happen somewhere in the brain of the learning person. From a natural scientist's point of view, learning is a process for which evolution prepared mankind very well and observing the breeding of highly developed creatures may give some insight into the process of learning as well. It seems to consist of three main steps: discovering or being pointed to a problem not encountered so far, looking how skilled co-living creatures solve it and trying to solve it on one's own; often the last two steps form a cycle in which communication and supervision is a main pace-setting force.

Thus, the question arises which matter can be learned (and taught!) using mobile devices? It has to be fully understandable by reading text, looking at figures, typing some text or number input and receiving feedback on the same level. We decided that an 'introduction to descriptive statistics' might be suitable for mobile learning, because it meets the mentioned requirements and is of practical use for somehow appraising the frequent statistical references given in media like television, newspapers and radio.

The most common 'mobile devices' of past generations of mobile learners have been a pile of printed paper to read from and another pile of paper to write on, but more and more of the present mobile learners make use of electronic devices, instead. The first kind of electronic device which became widely accepted for the purpose of mobile learning was the laptop, i.e. a small personal computer (PC). This change of device was accompanied by (we don't want to judge whether it was caused by or caused) a change of the main resource of information of the mobile learners: from printed matter in a library to files in the internet (documents, databases etc.). At least for the technically skilled learners, it was a change to their satisfaction.

A mobile device like a laptop itself can only serve as a tool to customise the relationship between the student and the material to be studied: modern viewer programs installed on a laptop can be adjusted to fit the needs of the vast majority of students and the student can store the conclusions drawn from the material on this laptop, i.e. notes, sketches etc. But an exchange of the information stored on the laptop with other persons could only take place in some kind of office: at least, a second computer or a telephone line had to be present to connect the laptop to. This is why the invention of cellular phones had such a big impact on mobile learning: by using cellular phones as radio modems the information exchange is practically no longer restricted, but moreover, the learning person can now communicate directly with others by calling them or sending an SMS or email.

From year to year, the cellular phones available in the stores got more powerful. In these days, a specific kind of cellular phones, called smartphones, combines characteristics of cellular phones and tiny PCs, i.e. they can be used to make phone calls and send SMS, but moreover, they have built-in functionality to access the internet to view web pages and send emails, and they have built-in organiser-functionality to manage contact information and time planning.

This report describes in detail how smartphones, especially those resembling the ERICSSON R380s, may be utilised for mobile learning purposes. The situation is analysed from the viewpoint of a content provider and of a mobile learner as well. To get an idea of the potential of using smartphones for mobile learning the use of some current combinations of PDAs and cellular phones is analysed, too.

1.1 Characteristics of electronic resp. mobile learning

This report focuses on the utilisation of electronic mobile devices for the purpose of distance learning. This means the learning person generally has no need to get into physical contact with the author of the learning material, the tutor of the course and other students. But all relevant studies (e.g.: A.J. Cropley and T.N. Kahl, 1983; B. Holmberg 1995; B. Holmberg and R. Schuemer, 1997) into distance education emphasise that effective communication with the tutor and other students is a key factor for successful distance learning.

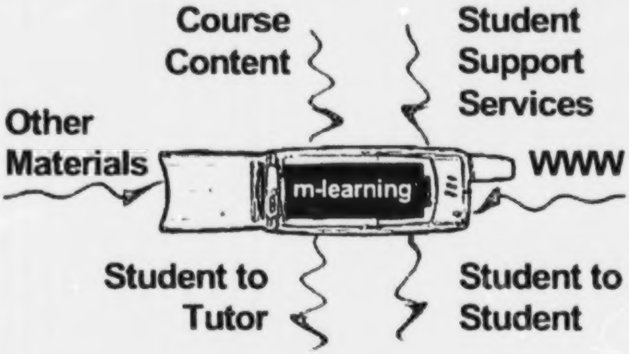


Figure 1-0: Communication channels in mobile learning

Therefore, a content provider in distance education should put as much effort as possible into the information and telecommunication (IT) environment used for distance education to provide suitable means for convenient student to tutor and student to student communication. We find the model depicted in fig. 1-0 is appropriate to describe the different communication channels typically used for mobile learning. Chapter 2 explains how these six channels for information exchange are realised in practice.

1.2 Presentation of scientific material

The course material should be presented in a form readable on almost all software platforms, and it should be easily accessible, i.e. ideally readable with software integrated in the operating system of the mobile device. The document format has at least to be able to display text, graphics and hyperlinks. And because we favour 'blended learning', i.e. the learning person should be able to choose the physical form of the learning material that best fits her resp. his needs, we recommend the courseware to be printable. This is an important point because the practice of m-learning shows that there are many situations where the battery power of current electronic devices is much too small for convenient use. Typically, mobile devices can be operated for a time span of approx. 4h before the batteries have to be re-charged. This means that they can't even be used during a long travel, not to speak of a camping holiday in a tent, e.g.

The following tables, though designed for ebooks, nevertheless give a summary of the available formats of electronic documents and their main features. The most suitable document formats seem to be HTML (hypertext mark-up language), PDF (portable document format), and eBook. The latter is analysed in detail in the second table.

I want to read eBooks on my:	**And I want my eBook to be:**			
	Printable	**Easy to read on-screen**	**Easy to navigate**	**Simple**
Windows PC	Adobe eBook, Adobe PDF, HTML, Instant eBook, Microsoft Word, Plain Text	Adobe eBook Microsoft Reader	Adobe eBook, Adobe PDF, Instant eBook, Microsoft Reader	HTML, Microsoft Word, Plain Text
Windows Tablet	Adobe eBook, Adobe PDF, HTML, Instant eBook, Microsoft Word, Plain Text	Adobe eBook Microsoft Reader	Adobe eBook, Adobe PDF, Instant eBook, Microsoft Reader	HTML, Microsoft Word, Plain Text
Macintosh	Adobe eBook, Adobe PDF, HTML, Microsoft Word, Plain Text	Adobe eBook Adobe PDF	Adobe eBook Adobe PDF	HTML, Microsoft Word, Plain Text
Linux/Unix computer	Adobe PDF, HTML, Plain Text	Adobe PDF	Adobe PDF	HTML Plain Text
Pocket PC	Not Printable	Microsoft Reader MobiPocket	Microsoft Reader MobiPocket	Microsoft Reader MobiPocket
Palm OS device	Not Printable	MobiPocket Palm Doc	MobiPocket	Palm Doc
Handheld PC	Not Printable	MobiPocket Palm Doc	MobiPocket	Palm Doc
Windows CE device	Not Printable	MobiPocket Palm Doc	MobiPocket	Palm Doc
EPOC device	Not Printable	MobiPocket	MobiPocket	MobiPocket
Gemstar / Rocket eBook	Not Printable	Gemstar eBook	Gemstar eBook	Gemstar eBook
Hiebook	Not Printable	hiebook	hiebook	hiebook

Table 1: ***Recommendations on document formats on various computer platforms*** **(reprinted with permission from: www.ebookmall.com)**

Format	Advantages	Reader Software	Navigation	Images	System
Adobe	CoolType, single or double page view	Get Acrobat eBook Reader Get Microsoft Internet Explorer	Library, Table of contents, Chapter links, bookmarkable	Yes	Windows
[illegible]	Cross-platform compatibility, printable	Get Acrobat Reader	Library, Table of contents, bookmarks	Yes	Windows, Macintosh, Linux, Unix, Palm
[illegible]	Dedicated reader for eBooks, carry titles with you	[illegible]	Library, Table of contents, bookmarks	Yes	Windows
hiebook	Dedicated reader for eBooks, includes lots of other programs	hiebook	Library, Table of contents, bookmarks	Yes	Windows
HTML	Easy to use, customisable, can be read on anything with a browser	Get Microsoft Internet Explorer Netscape NOW! MOBIPOCKET Reader	Hypertext links	Yes (*)	Windows, Macintosh, Linux, Unix, Palm, Pocket PC, eBookMan
[illegible]	No special reader software required	Get Microsoft Internet Explorer	Hypertext links	Yes	Windows
Microsoft Reader	ClearType	eBooks are Here!	Library, Table of contents, Chapter links, bookmarkable	Yes	Windows, Pocket PC
W	Familiar environment, printable	W	Hypertext links	Yes	Windows, Macintosh
MOBIPOCKET	Can be used on any PDA	MOBIPOCKET Reader	Library, Table of contents, Chapter links, bookmarkable	Yes	Palm, Pocket PC, eBookMan
Text	Very simple, can be read on just about anything	MOBIPOCKET Reader	None	No	Windows, Macintosh, Linux, Unix, Palm, Pocket PC, eBookMan
[illegible]	Great simple eBooks	get CSpotRun! MOBIPOCKET Reader	Limited in CspotRun, similar to Microsoft Reader in MobiPocket	No	Palm, Handheld PC, Windows CE

Table 2: *Comparison of eBook formats on various computer platforms* **(reprinted with permission from: www.ebookmall.com; * erroneous entry 'no' in the original document)**

Summarising the information given, the document formats HTML and PDF as well as MOBIPOCKET eBooks theoretically seem to be optimal for supporting mobile learners in the sense that these formats can be displayed on almost all mobile devices running almost all different operating systems.

But not on the R380s! It's running the operating system EPOC, but only has a WAP browser installed and there is no way to install additional software. And now for something completely different: the R380s in practice.

BEST COPY AVAILABLE

10

1.3 The smartphone R380s

1.3.1 The appearance of the R380s

The next two pictures show the R380s as seen from the front side and nearly at true scale.

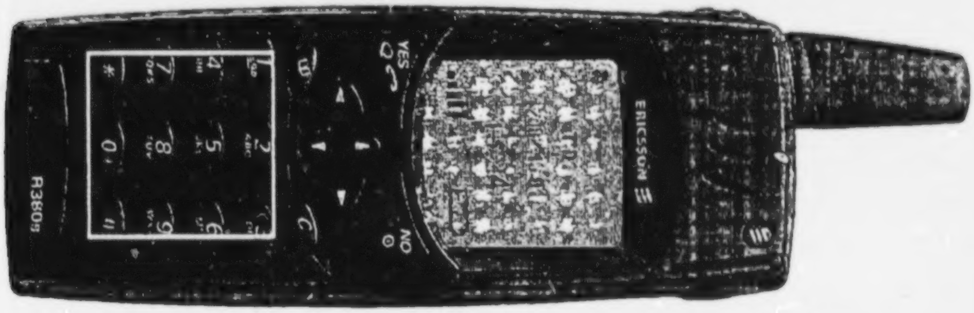


Figure 1-1: The R380s in telephony-mode, i.e. its flip is closed (square: 3x3cm^2).

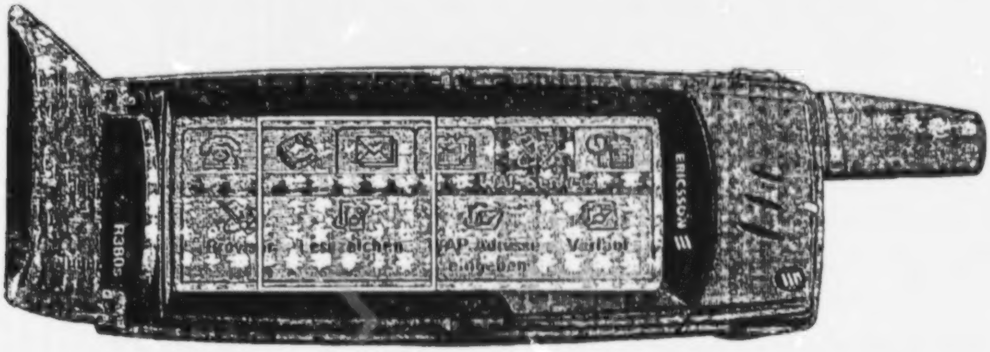


Figure 1-2: The R380s in PDA-mode, i.e. its flip is opened (square: 3x3cm^2).

If this page is printed as a DIN A4 page, fig. 1-1 and 1-2 show the R380s in natural scaling.

The R380s is operated via its touch screen, even in telephony mode, as can be seen from the small nipples on the back side of the flip. In PDA-mode (PDA means personal digital assistant), a stylus is used for that purpose. This means you need both hands for operating the phone. The contrast of the display is low; the background colour may be said to resemble a mud green, the foreground colour is closer to grey than to black, regardless of the level of contrast chosen in the 'settings' menu.

The R380s can only use the CSD (circuit switched data) technique for any connections, thus the maximum data transmission rate is 9600 baud, i.e. approximately 1.2kBytes/sec.

1.3.2 The built-in software of the R380s

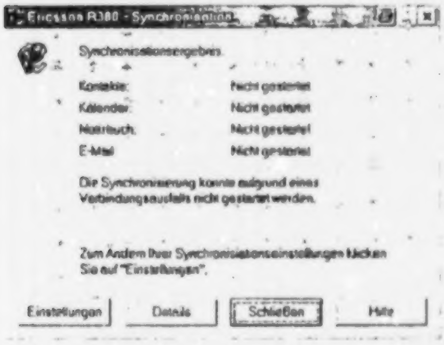
The only document formats the R380s can display are plain text as used for SMS and emails, and WML-pages which may contain black and white pictures. These pages are documents written in the mark-up language WML (wireless mark-up language) and transmitted to the phone using WAP (wireless application protocol). The WML language was designed for use on mobile devices and provides some means of directly accessing the phones capabilities.

The most apparent differences between content provided in the WWW (world wide web), which usually is presented as HTML pages, and WML (version 1.1 to 1.3) pages are:

- in WML very small maximum document size (R380s approx. 4kByte)
- in WML only black&white graphics formatted as WBMP (wireless bitmap)
- in WML there is no stuff like plug-ins, Java etc.
+ WML is fully Unicode 2.0 enabled
? the scripting language WMLS cannot be de-activated by the users

1.3.3 The PDA features of the R380s

The R380s has built-in PDA functionality. It provides simple applications to manage dates, contacts and a phone book. The software bundled with the R380s comprises the PIM (personal information manager) application Lotus Organizer V5, which was chosen to test the quality of synchronisation between the R380s and a PC running MS-Windows ME. We did not want to install MS-Outlook for security reasons, the PC in the ZIFF were not properly protected against hackers at the beginning of the project. So the following figures show how a contact defined on the PC in Lotus Organizer is transferred to the R380s and how a different contact defined on the R380s is transferred to the PC. The procedure of connecting the R380s to the PC was and still is a torture. Physically, a serial cable is used because the PC isn't equipped with an IrDA port. The cable is always attached to a serial port of the PC but to the R380s only when needed. The synchronising application always starts when the cable is attached to the R380s, but mostly an error message pops up after a few seconds that tells about connection problems, as can be seen in fig. 1-3 (the text is in German and reads: result of synchronisation: contacts -etc.- not started // the synchronisation couldn't be started due to a connection failure // to change your synchronisation settings click on settings). At first, we didn't manage to connect the phone at all. We updated the connection and phone software, but that did not solve this problem. A search in the web yielded one valuable result: after lowering the speed of the serial port to a maximum of 9600 Baud, sometimes a connection is established.



Synchronisationsergebnis

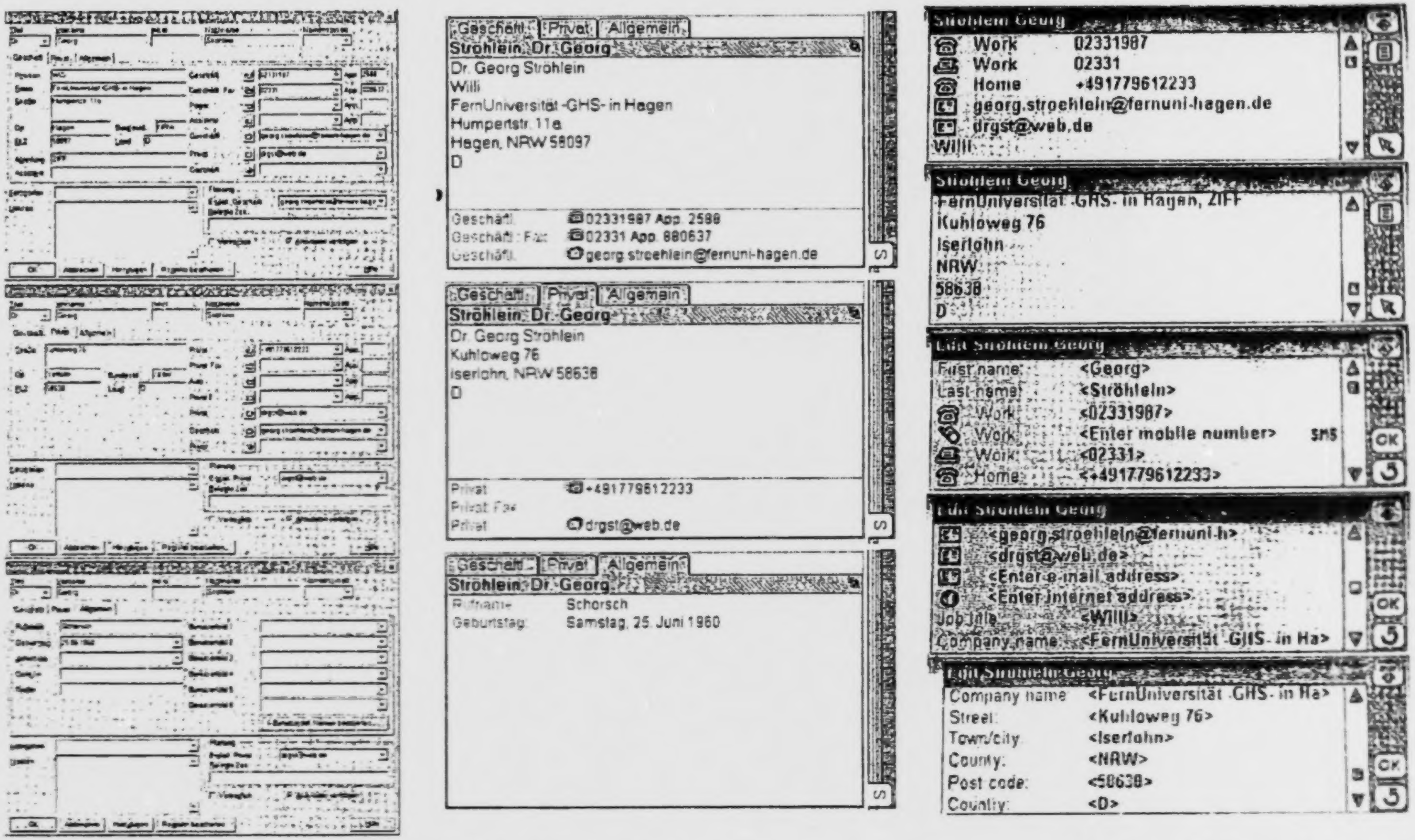
Kontakte: Nicht gestartet
Kalender: Nicht gestartet
Notizbuch: Nicht gestartet
E-Mail: Nicht gestartet

Die Synchronisierung konnte aufgrund eines Verbindungsausfalls nicht gestartet werden.

Zum Ändern Ihrer Synchronisationseinstellungen klicken Sie auf "Einstellungen".

Figure 1-3: Synchronisation error message

BEST COPY AVAILABLE



Geschäft Privat Allgemein
Ströhlein, Dr. Georg
Dr. Georg Ströhlein
Willi
FernUniversität -GHS- in Hagen
Humperstr. 11a
Hagen, NRW 58097
D

Geschäft: ☎02331987 App. 2598
Geschäft: Fax: ☎02331 App. 880637
Geschäft: georg.stroehlein@fernuni-hagen.de

Geschäft Privat Allgemein
Ströhlein, Dr. Georg
Dr. Georg Ströhlein
Kuhloweg 76
Iserlohn, NRW 58638
D

Privat: ☎+491779612233
Privat Fax:
Privat: drgst@web.de

Geschäft Privat Allgemein
Ströhlein, Dr. Georg
Rufname: Schorsch
Geburtstag: Samstag, 25. Juni 1960

Ströhlein Georg
☎ Work 02331987
Work 02331
☎ Home +491779612233
georg.stroehlein@fernuni-hagen.de
drgst@web.de
Willi

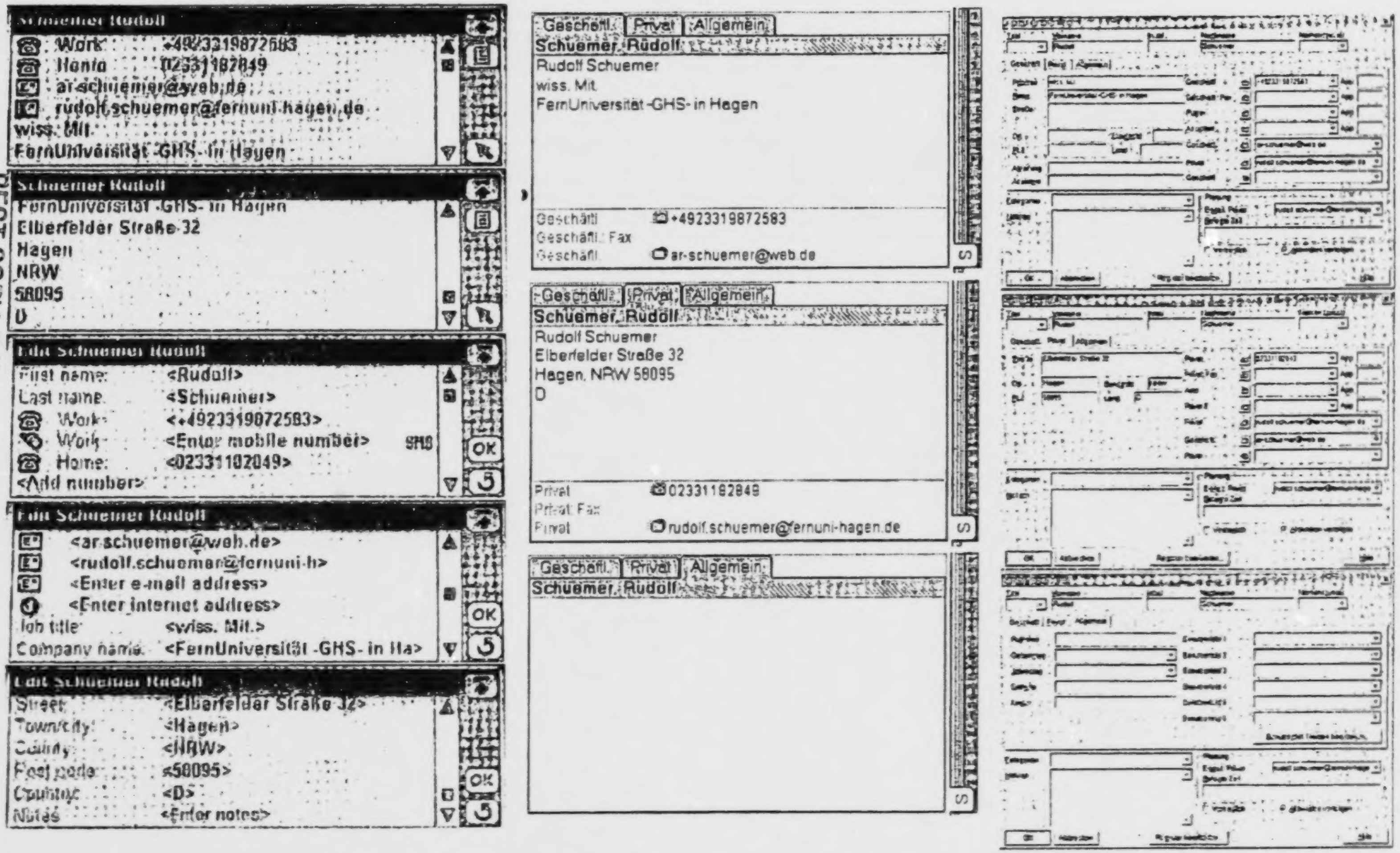
Ströhlein Georg
FernUniversität -GHS- in Hagen, ZIFF
Kuhloweg 76
Iserlohn
NRW
58638
D

Edit Ströhlein Georg
First name: <Georg>
Last name: <Ströhlein>
☎ Work: <02331987>
Work: <Enter mobile number> SMS
Work: <02331>
☎ Home: <+491779612233>

Edit Ströhlein Georg
<georg.stroehlein@fernuni-h>
<drgst@web.de>
<Enter e-mail address>
<Enter internet address>
Job title: <Willi>
Company name: <FernUniversität -GHS- in Ha>

Edit Ströhlein Georg
Company name: <FernUniversität -GHS- in Ha>
Street: <Kuhloweg 76>
Town/city: <Iserlohn>
County: <NRW>
Post code: <58638>
Country: <D>

Figure 1-4: Defining a contact in Lotus Organizer 5.1 and after transfer to R380s



Schuemer Rudolf
Work: +4923319872583
Home: 02331182849
ar.schuemer@web.de
rudolf.schuemer@fernuni-hagen.de
wiss. Mit.
FernUniversität -GHS- in Hagen

Schuemer Rudolf
FernUniversität -GHS- in Hagen
Elberfelder Straße 32
Hagen
NRW
58095
D

Edit Schuemer Rudolf
First name: <Rudolf>
Last name: <Schuemer>
Work: <+4923319872583>
Work: <Enter mobile number>
Home: <02331182849>
<Add number>

Edit Schuemer Rudolf
<ar.schuemer@web.de>
<rudolf.schuemer@fernuni-h>
<Enter e-mail address>
<Enter internet address>
Job title: <wiss. Mit.>
Company name: <FernUniversität -GHS- in Ha>

Edit Schuemer Rudolf
Street: <Elberfelder Straße 32>
Town/city: <Hagen>
County: <NRW>
Post code: <58095>
Country: <D>
Notes: <Enter notes>

Schuemer, Rudolf
Rudolf Schuemer
wiss. Mit.
FernUniversität -GHS- in Hagen
Geschäftl: +4923319872583
Geschäftl.: Fax
Geschäftl: ar-schuemer@web.de

Schuemer, Rudolf
Rudolf Schuemer
Elberfelder Straße 32
Hagen, NRW 58095
D
Privat: 02331182849
Privat: Fax
Privat: rudolf.schuemer@fernuni-hagen.de

Schuemer, Rudolf

Figure 1-5: Defining a contact on the R380s and after transfer to Lotus Organizer 5

As can be seen from fig. 1-4, transferring a contact from the PC to the phone makes a mess out of the private and business entries: the dialling code is kept but the apparatus number is lost, the name of the company is followed by the private address and so on. But what happens if a contact is transferred from the phone to the PC? Look at fig. 1-5: the coincidence of entries is better in this case, as could be expected because we now knew what to enter, but still failed in guessing which entry corresponds to the private resp. business email address. Summarising, the synchronisation of contacts is not an argument to buy the phone. Extensive trial and error testing with Lotus Organizer would be necessary to define a correct filing.

1.4 Summary

The R380s is a cellular phone with a touch screen of about three times the size of the display of common mobile phones. In phone mode, approximately two thirds of the touch screen are covered by a flip with usual telephone buttons on the front side. The R380s is a dual band (900/1800) CSD phone, which means modern and fast transmission technologies like HSCSD or GPRS cannot be used.

Due to the fact that none of the mobile service providers in Germany offers an SMS configuration service for the R380s, the WAP services had to be configured manually, which was a tedious procedure. The built-in WAP browser is fast and stable.

The PDA functionality of the R380s is sufficient for most purposes, but the synchronisation procedure with a common PC running MS-Windows ME is a torture: only searching the web led to success by reducing the parameter value for the maximum connection speed of the serial port to 9600 Baud in the Windows systems settings menu. The pre-defined Lotus Organizer R5 sheets for keeping the contacts do not fit well to the contact entries as defined in the R380s, private and business entries are mixed up when synchronising.

2 IT-environment for mobile learners

This chapter describes some of the steps necessary to upgrade an existing IT environment for the needs of mobile learning. At first, the web server has to be upgraded. This part is off-topic here; for the common web server programs like *Apache* the procedure may be found in the internet. For educational institutions, free versions of the necessary program modules are available, but for large throughput, an additional so-called WAP-proxy may be necessary.

From the content provider's point of view, the changes in the IT environment are minor if they are applied to a running electronic learning environment, and only this case is described here. So we assume the content on the web server related to electronic learning is provided to the students through the internet using HTTP (hypertext transfer protocol) or FTP (file transfer protocol) as medium and HTML, at least basically, as meta language to describe the content of the web pages to the browsers by which students access them.

We now introduce different levels of access to the content on the web server related to mobile learning: if content or services are accessed by a cellular phone using WAP as a medium and WML as the meta language, we'll call this 'mobile access' because it utilises the new technologies available only since the invention of cellular phones. If a cellular phone is used as a radio modem to connect a laptop or PDA to the internet by using HTML as medium and HTML as meta language, we'll call it 'mobile off-line access', because typically the connection is used to download material which is viewed after the mobile connection has been closed.

These different kinds of access are usually related to very different amounts of data transferred during the on-line time: while during a mobile access typically 10 WML pages are viewed and thus approximately 10 Kbytes of data are transferred, the amount of data downloaded for mobile off-line access may well reach 1 MByte.

Now the server side (content provider) and client side (mobile learner) of the process of information exchange for mobile learning is described in detail, focussing on the new WML/WAP content type.

2.1 The server side

2.1.1 Providing mobile access to the course content

The content in WML(S) format is usually of unknown structure to the web server ('web server' means a program running on a computer which is answering the queries of the browsers running on the client devices as well as the computer itself). For the wide-spread web server APACHE, this problem may be solved by adding a specific file to the directory in which the content is stored (apart from adding a WAP-proxy module or stand-alone computer). It is called '.htaccess' and adds the proper MIME-types (see http://www.devarticles.com/art/1/85/2, e.g.):

```
AddType text/vnd.wap.wml                wml     (plain documents)
AddType application/vnd.wap.wmlc        wmlc    (compiled documents)
AddType text/vnd.wap.wmlscript          wmls    (plain scripts)
AddType application/vnd.wap.wmlscriptc  wmlsc   (compiled scripts)
AddType image/vnd.wap.wbmp              wbmp    (b&w graphics)
```

The content may be transferred from the PC on which it was created to the web server by using any common FTP program which is already used to transfer the content in HTML format. But how are these new types of content created? The following text gives some hints.

2.1.2 Creating content formatted in WML(S) / WBMP

WML and WMLS are both ASCII-formats, so they could basically be created using any text editor. But for more complex projects, an IDE (integrated development environment) is recommended. The following screenshots give examples of the IDEs available for free from

ERICSSON and NOKIA. The first question in the course developed at ZIFF serves as an example, in conventional text form it reads:

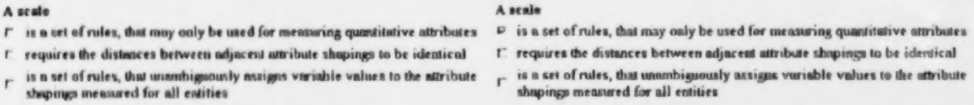
A scale

☐ is a set of rules, that may only be used for measuring quantitative attributes

☐ requires the distances between adjacent attribute shapings to be identical

☐ is a set of rules, that unambiguously assigns variable values to the attribute shapings measured for all entities

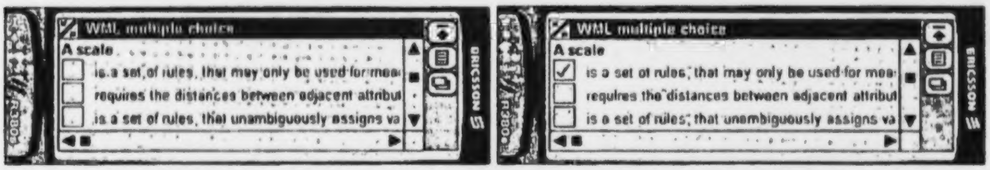
The students' task now is to find and mark all the correct answers among the given ones, i.e. a so-called multiple-choice test. To properly lay-out this example in HTML, a table would be used for alignment (as it is in this document) and the so-called checkbox element within a so-called form element of the document would provide the necessary interactive element to store a student's answer. The square as indicator of a checkbox is chosen according to the conventional appearance in HTML (see fig. 2-1a). The result was:



A scale
☐ is a set of rules, that may only be used for measuring quantitative attributes
☐ requires the distances between adjacent attribute shapings to be identical
☐ is a set of rules, that unambiguously assigns variable values to the attribute shapings measured for all entities

A scale
☑ is a set of rules, that may only be used for measuring quantitative attributes
☐ requires the distances between adjacent attribute shapings to be identical
☐ is a set of rules, that unambiguously assigns variable values to the attribute shapings measured for all entities

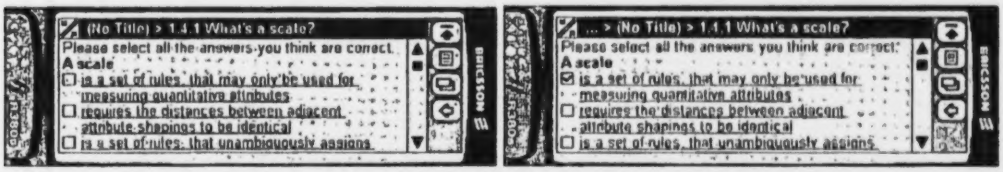
Figure 2-1a: Example in HTML and with 1st choice selected



A scale
☐ is a set of rules, that may only be used for mea
☐ requires the distances between adjacent attribut
☐ is a set of rules, that unambiguously assigns va

A scale
☑ is a set of rules, that may only be used for mea
☐ requires the distances between adjacent attribut
☐ is a set of rules, that unambiguously assigns va

Figure 2-1b: Example in WML (IDE 3.11 browser) and with 1st choice selected



(No Title) > 1.4.1 What's a scale?
... > (No Title) > 1.4.1 What's a scale?
R380s
ERICSSON

Please select all the answers you think are correct.
A scale
☐ is a set of rules, that may only be used for measuring quantitative attributes
☐ requires the distances between adjacent attribute shapings to be identical
☐ is a set of rules, that unambiguously assigns

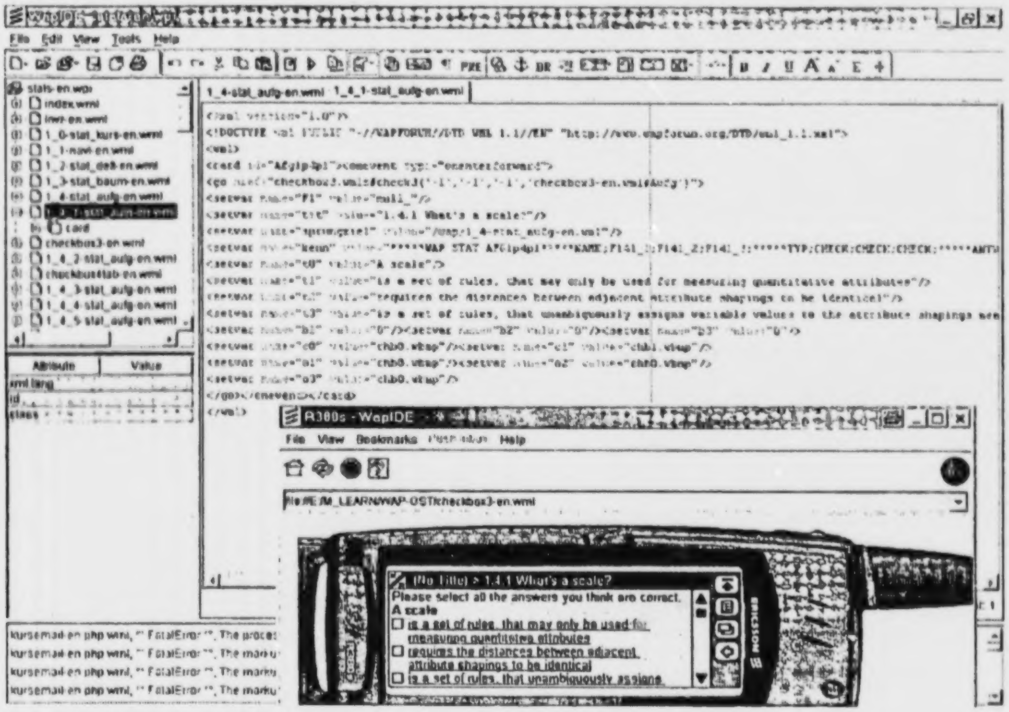
Please select all the answers you think are correct:
A scale
☑ is a set of rules, that may only be used for measuring quantitative attributes
☐ requires the distances between adjacent attribute shapings to be identical
☐ is a set of rules, that unambiguously assigns

Figure 2-1c: Example in WMLS (IDE 3.11 browser) and with 1st choice selected

According to fig. 2-1a, the feed-back mechanism for successful selection in HTML is a small hook in the checkbox. So how does this piece of content appear in WML and on the R380s?

Fig. 2-1b reveals a main disadvantage of WML (at least it's realisation on the R380s): for some WML elements the browser forces the user to scroll horizontally instead of breaking the lines, and horizontal scrolling is always rated most inconvenient in all relevant studies. So this has definitely to be avoided by a more tricky layout; our final version looks like fig. 2-1c. Using tables is impossible here, because the very strict rules of WML state that the <table>-

tags aren't allowed within a pair of <select>-</select>-tags and vice versa. On top of that, the checkboxes are too big so that valuable space is wasted and the layout looks unbalanced. So a trick has to be used: the checkboxes are represented by images and used as graphical links. The text of an answer is coded as link, too, and thus makes it much easier for a student to select a choice. But how to process an interaction now? By using the built-in scripting language WMLS! It may not be de-activated by the user, so it is known to work, in contrast to the situation for the web, where people frequently switch off JavaScript resp. ActiveScripting due to security concerns.


File Edit View Tools Help
1_4-stat_aufg-en.wml 1_4_1-stat_aufg-en.wml
Attribute Value
R380s - WapIDE
File View Bookmarks Help
ERICSSON

(No Title) > 1.4.1 What's a scale?

Please select all the answers you think are correct.

A scale

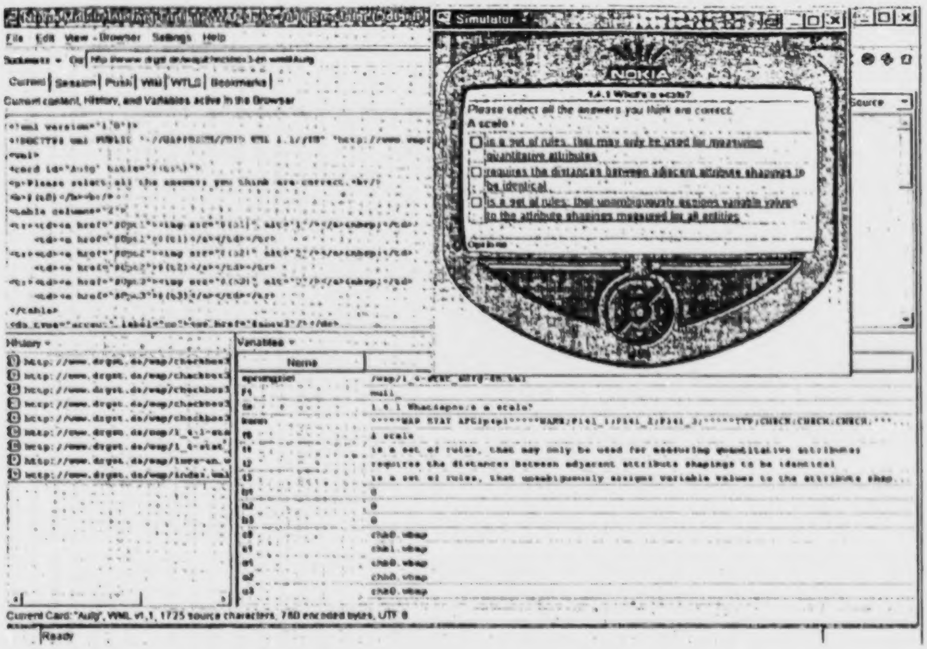
☐ is a set of rules, that may only be used for measuring quantitative attributes

☐ requires the distances between adjacent attribute shapings to be identical

☐ is a set of rules, that unambiguously assigns

Figure 2-2: WML(S) page displayed in ERICSSON IDE 3.11

But with increasing complexity of the material, e.g. the content of all the variables defined in the WMLS code, it is recommended to use an IDE (integrated development environment) for creating the WML(S) pages. We tried out two different IDEs provided by ERICSSON (V 3.11) and by NOKIA (V 3.0), resp. The figures 2-2 and 2-3 show how the example displayed in fig. 2-1 shows up in these two IDEs.



1.4.1 What's a scale?

Please select all the answers you think are correct.

A scale :

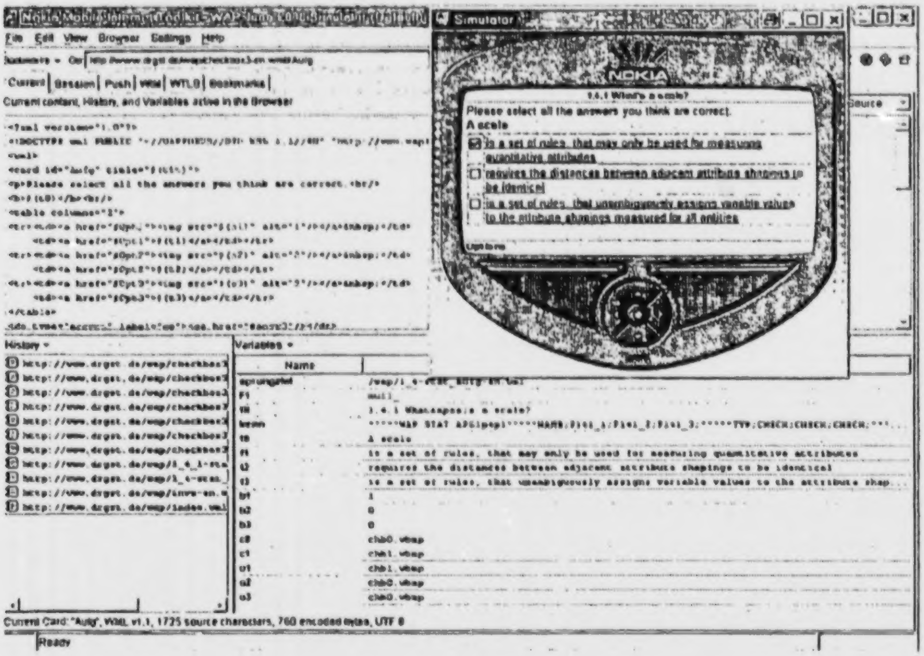
☐ is a set of rules, that may only be used for measuring quantitative attributes

☐ requires the distances between adjacent attribute shapings to be identical

☐ is a set of rules, that unambiguously assigns variable values to the attribute shapings measured for all entities

Simulator
NOKIA
Current
Session
Push
WMl
WTLS
Bookmarks
History
Variables
Name
Source
Ready

Figure 2-3a: WML page with an embedded script as displayed in NOKIA WIT 3.00 Initial appearance of the page



1.4.1 What's a scale?

Please select all the answers you think are correct.

A scale

☑ is a set of rules, that may only be used for measuring quantitative attributes

☐ requires the distances between adjacent attribute shapings to be identical

☐ is a set of rules, that unambiguously assigns variable values to the attribute shapings measured for all entities

Simulator
NOKIA
File
Edit
View
Browser
Settings
Help
Current
Session
Push
WMl
WTLS
Bookmarks
History
Variables
Name
Source
Ready

Figure 2-3b: WML page with an embedded script as displayed in NOKIA WIT 3.00 Appearance of the page after selecting the first answer choice. The content of the variables defined in the page and script has changed, too!

Below the task bar, the top left window shows all the files contained in the current project, the top right window shows the code of the active file, the middle left window shows the attributes of the active card, i.e. a sub-unit of a WML file, and the bottom window, which is partially hidden by the emulator, shows error messages occurred when compiling all the files. On compilation, the syntax of the WML(S) page is checked and any errors are reported. To our experience, the corresponding messages make sense in almost all cases. But there is a problem with the strict rules for file extensions allowed within a project: as we had to do some server side scripting and used PHP as language for that purpose. So there are files with the extension PHP which essentially contain WML code and definitely belong to the project. But PHP files may not be included in a WPR project, so we used the double extension trick and added a '.wml' to fake the PHP files were WML files. Now they could be included in a WPR project but obviously, the compiler cannot handle their content and a huge amount of error messages results which are completely worthless for the developer.

In the code window we see that the ERICSSON IDE supports syntax high-lighting, but there is no way to keep track of the values of those variables defined in a WML(S) page. But this is essential if the code contains any bugs and does not work as expected. So we tried the other IDE offered by NOKIA. The disadvantage of this IDE obviously is that it does not allow to display the content on an emulated display with an aspect ratio close to that of the R380s.

From fig. 2-3 it is obvious that the NOKIA IDE allows for conveniently testing the WML scripts. But the problem with the PHP pages essentially containing WML content still persists. And it is a very awkward one, because if there is an error, the corresponding error message from the web server isn't formatted in WML but in HTML, so it cannot be displayed within the WAP browsers. For that purpose, a third tool had to be used, for convenience; we chose the browser OPERA 5 which can handle both HTML and WML formatted pages. It cannot handle WMLS pages, so PHP scripts containing WMLS content were definitely to be avoided as there was and still is no software for convenient testing in this case.

Another problem arises with the small screen size of the R380s. In many cases we encountered problems with the display of the content, especially the word wrapping in those cases when long words are used is crucial. And for usability testing, the size of an emulator's screen and its aspect ratio should closely match the values of the original display. But things are bad here, too, as can be seen in the following fig. 2-4.

It is interesting that the emulator provided by the manufacturer of the R380s is less true to the original than the one provided by a freeware (adware) tool. And this hints to another crucial problem encountered during content creation: the hyphenation (syllabification) of text.

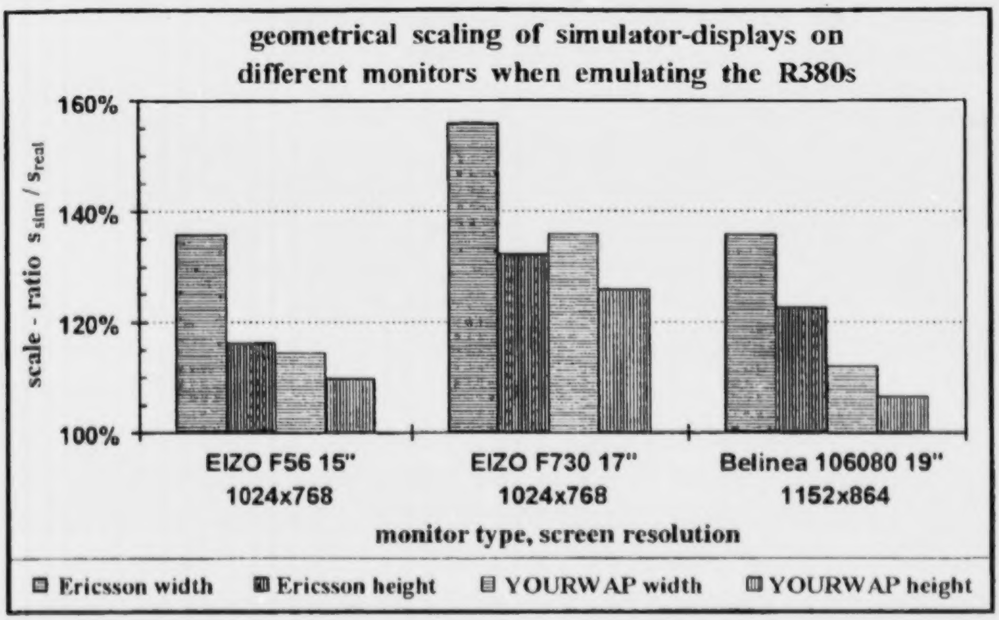


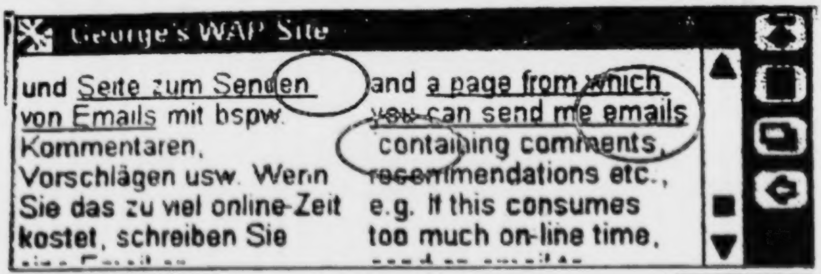
Figure 2-4: Size and scaling of two R380s emulators

Due to the small screen it seems desirable not to waste space at the end of lines and to avoid a saw tooth like right text border. Unfortunately, the WAP browser of the R380s does not support automatic syllabification, so we tried to manually add this feature during content creation. But none of the emulators used gave a correct and reliable idea of where to break the words, as can be concluded from the following figures.

Figure 2-5c shows the layout of a WML page as produced by the ERICSSON WAP IDE V. 3.11, i.e. the tool used for developing the courseware. The layout significantly differs from that on the real phone, as can be seen from fig. 2-5a. There is another tool available from ERICSSON's, the so-called R380s emulator, the layout of which can be seen in fig. 2-5b. It is very close to that of the real phone, if the background colour isn't concerned. But this emulator needs all the WML files to be compiled to WMLC, e.g. using the WAP IDE, and placed in a special directory, so the process of manually adding word breaks is much too tedious to be applied to a large course text.

Another problem is apparent from figs. 2-5a,b: the WAP browser does not handle white spaces (blanks) and punctuation marks between two adjacent words correctly if there is a WML tag, too. This is confirmed by the following figure which is preceded by a snippet of the WML source code (only English part; [CR][LF] means a line break in the WML file):

```
<td>and <a href="#contact">a page from which you can send me
emails</a> containing [CR][LF]comments, recommendations etc., e.g.
If this consumes too [CR][LF]much on-line time, send an email to
<b>webmaster@drgst.de</b></td>
```

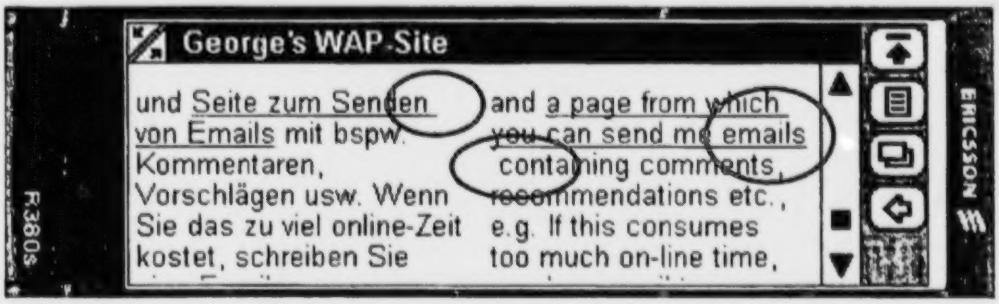


George's WAP Site

und Seite zum Senden
von Emails mit bspw.
Kommentaren,
Vorschlägen usw. Wenn
Sie das zu viel online-Zeit
kostet, schreiben Sie

and a page from which
you can send me emails
containing comments,
recommendations etc.,
e.g. If this consumes
too much on-line time,

Figure 2-5a: Layout of WML page (R380s, digitally processed picture)

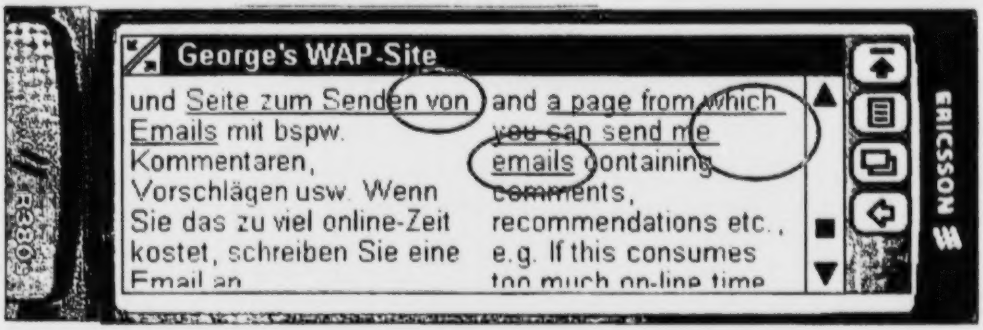


George's WAP-Site

und Seite zum Senden
von Emails mit bspw.
Kommentaren,
Vorschlägen usw. Wenn
Sie das zu viel online-Zeit
kostet, schreiben Sie

and a page from which
you can send me emails
containing comments,
recommendations etc.,
e.g. If this consumes
too much on-line time,

Figure 2-5b: Layout of WML page (ERICSSON R380s emulator)



George's WAP-Site

und Seite zum Senden von
Emails mit bspw.
Kommentaren,
Vorschlägen usw. Wenn
Sie das zu viel online-Zeit
kostet, schreiben Sie eine

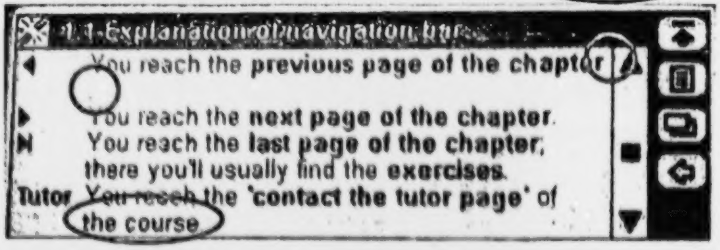
and a page from which
you can send me
emails containing
comments,
recommendations etc.,
e.g. If this consumes

Figure 2-5c: Layout of WML page (ERICSSON WAP-IDE 3.11 browser)

But there is a good point, too: the WAP browser of the R380s is UNICODE 2.0 enabled. UNICODE is a standard of addressing any known character on the world by a specific number. Using UNICODE instead of ISO-character-schemes should solve the problem of language trouble known from the WWW.

For example, it is impossible to display a specific text in all languages of the members of the European Union on a single HTML page without UNICODE, as the Greek characters are not included in the standard Western European character set. Look at the homepage of the EU (http://www.europa.eu.int/), e.g. The text "The European Union On-Line" is written there in 11 languages, using GIF images instead of text (latest check for that on Dec, 12 2002).

```
<tr><td><img src="zurueck.wbmp" alt="back"/></td>
<td>You reach the <b>previous page of the chapter</b>.</td></tr>
```



1.1 Explanation of navigation bar

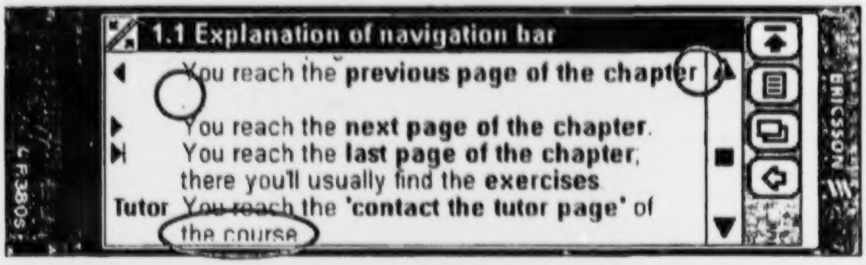
◀ You reach the **previous page of the chapter**

▶ You reach the **next page of the chapter**.

⏭ You reach the **last page of the chapter**; there you'll usually find the **exercises**.

Tutor You reach the **'contact the tutor page'** of the course

Figure 2-6a: Line breaks and punctuation marks (R380s, digitally processed photo)



1.1 Explanation of navigation bar

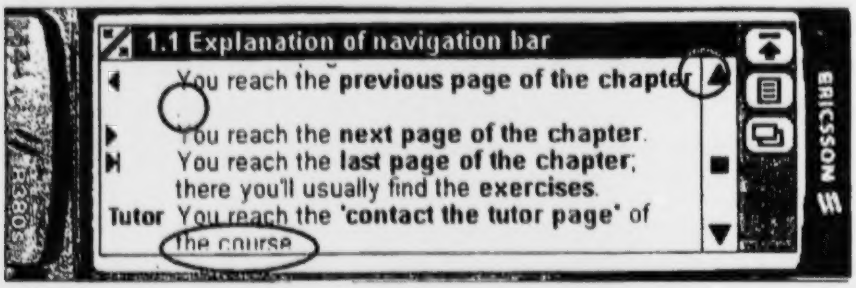
◀ You reach the **previous page of the chapter**

▶ You reach the **next page of the chapter**.

⏭ You reach the **last page of the chapter**; there you'll usually find the **exercises**.

Tutor You reach the **'contact the tutor page'** of the course

Figure 2-6b: Line breaks and punctuation marks (R380s emulator)



1.1 Explanation of navigation bar

◀ You reach the **previous page of the chapter**

▶ You reach the **next page of the chapter**.

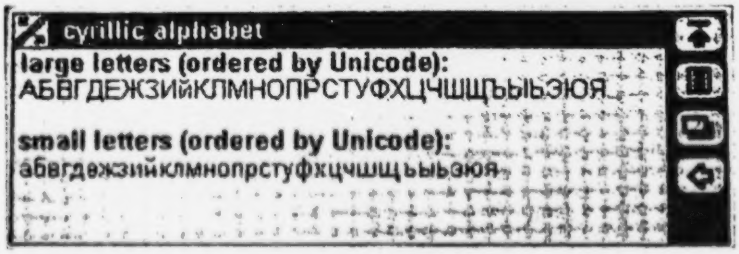
⏭ You reach the **last page of the chapter**; there you'll usually find the **exercises**.

Tutor You reach the **'contact the tutor page'** of the course

Figure 2-6c: Line breaks and punctuation marks (IDE 3.11 browser)

But the following figures and the leading WML code snippets show how to use UNICODE for displaying multi-lingual information on one WML page, which may be interesting in terms of the EU enlargement in the near future, as it basically holds for modern web browsers, too:

```
<p><b>capital letters (ordered by Unicode):</b><br/>
&#1040;&#1041;&#1042;&#1043;&#1044;&#1045;&#1046;&#1047;&#1048;
&#1049;&#1050;&#1051;&#1052;&#1053;&#1054;&#1055;&#1056;&#1057;
&#1058;&#1059;&#1060;&#1061;&#1062;&#1063;&#1064;&#1065;&#1066;
&#1067;&#1068;&#1069;&#1070;&#1071;<br/><br/>
<b>small letters (ordered by Unicode):</b><br/>
&#1072;&#1073;&#1074;&#1075;&#1076;&#1077;&#1078;&#1079;&#1080;
&#1081;&#1082;&#1083;&#1084;&#1085;&#1086;&#1087;&#1088;&#1089;
&#1090;&#1091;&#1092;&#1093;&#1094;&#1095;&#1096;&#1097;&#1098;
&#1099;&#1100;&#1101;&#1102;&#1103;
```

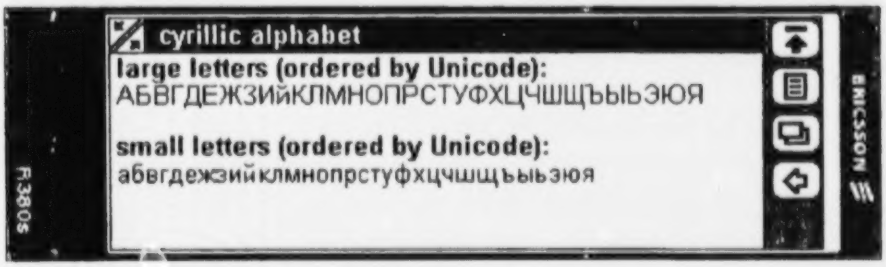


cyrillic alphabet

large letters (ordered by Unicode):
АБВГДЕЖЗИйКЛМНОПРСТУФХЦЧШЩЪЫЬЭЮЯ

small letters (ordered by Unicode):
абвгдежзийклмнопрстуфхцчшщъыьэюя

Figure 2-7a: Cyrillic alphabet (R380s, digitally processed photo)

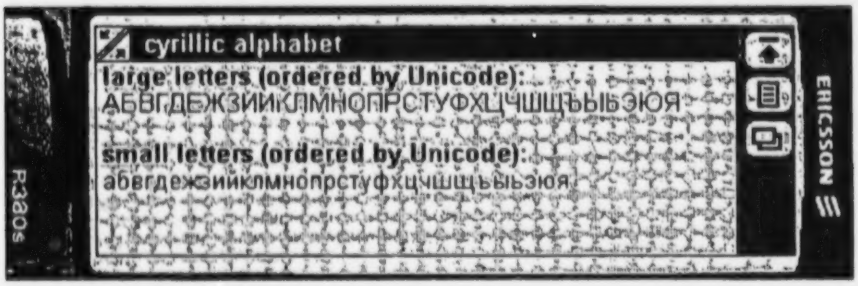


cyrillic alphabet

large letters (ordered by Unicode):
АБВГДЕЖЗИйКЛМНОПРСТУФХЦЧШЩЪЫЬЭЮЯ

small letters (ordered by Unicode):
абвгдежзийклмнопрстуфхцчшщъыьэюя

Figure 2-7b: Cyrillic alphabet (R380s emulator)



cyrillic alphabet

large letters (ordered by Unicode):
АБВГДЕЖЗИйКЛМНОПРСТУФХЦЧШЩЪЫЬЭЮЯ

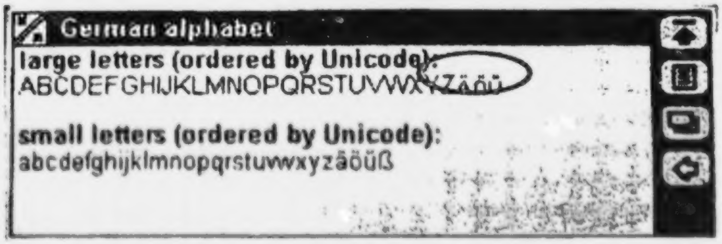
small letters (ordered by Unicode):
абвгдежзийклмнопрстуфхцчшщъыьэюя

Figure 2-7c: Cyrillic alphabet (R380s browser)

The implementation of Unicode is good point for the WAP browser of the R380s, and it gives rise to the expectation that the German so-called Umlauts can be easily displayed as well. The following figures show the result when using the German instead of the Cyrillic alphabet.

```
<p><b>large letters (ordered by Unicode):</b><br/>
&#65;&#66;&#67;&#68;&#69;&#70;&#71;&#72;&#73;&#74;&#75;&#76;&#77;
&#78;&#79;&#80;&#81;&#82;&#83;&#84;&#85;&#86;&#87;&#88;&#89;&#90;
&#196;&#214;&#220;<br/><br/>
<b>small letters (ordered by Unicode):</b><br/>
&#97;&#98;&#99;&#100;&#101;&#102;&#103;&#104;&#105;&#106;&#107;
&#108;&#109;&#110;&#111;&#112;&#113;&#114;&#115;&#116;&#117;&#118;
&#119;&#120;&#121;&#122;&#228;&#246;&#252;&#223;</p>
```

Basically, the Umlauts are perfectly supported, but the layout of the capital Umlauts in ERICSSON's WAP IDE is horribly bad. In contrast to HTML (using "&Uuml;" to code the letter "Ü", e.g.) in WML there are no so-called entities to describe the Umlauts. This means spell-checking is a little bit different.

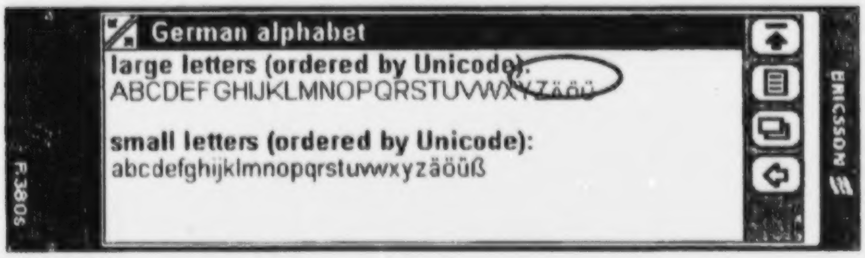


German alphabet

large letters (ordered by Unicode):
ABCDEFGHIJKLMNOPQRSTUVWXYZäöü

small letters (ordered by Unicode):
abcdefghijklmnopqrstuvwxyzäöüß

Figure 2-8a: German alphabet (R380s, digitally processed photo)

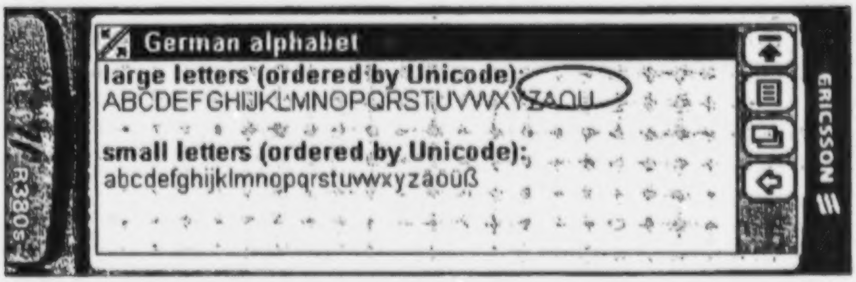


German alphabet

large letters (ordered by Unicode):
ABCDEFGHIJKLMNOPQRSTUVWXYZäöü

small letters (ordered by Unicode):
abcdefghijklmnopqrstuvwxyzäöüß

Figure 2-8b: German alphabet (R380s emulator)



German alphabet

large letters (ordered by Unicode):
ABCDEFGHIJKLMNOPQRSTUVWXYZAOU

small letters (ordered by Unicode):
abcdefghijklmnopqrstuvwxyzäöüß

Figure 2-8c: German alphabet (IDE 3.11 browser)

Thus, we developed a MS-Word97 macro to convert content formatted in WML and using Unicodes to encode German Umlauts to standard text and vice versa. See how "&#220;" is converted to an "Ü" and vice versa:

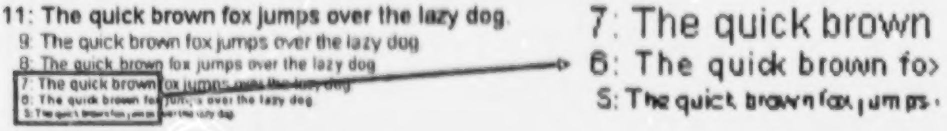
```
Selection.Find.Execute Replace:=wdReplaceAll
With Selection.Find
    .Text = "&#220;"
    .Replacement.Text = "Ü"
    .Forward = True
    .Wrap = wdFindAsk
    .Format = False
    .MatchCase = True
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
```

```
Selection.Find.Execute Replace:=wdReplaceAll
With Selection.Find
     .Text = "Ü"
     .Replacement.Text = "&#220;"
     .Forward = True
     .Wrap = wdFindAsk
     .Format = False
     .MatchCase = True
     .MatchWholeWord = False
     .MatchWildcards = False
     .MatchSoundsLike = False
     .MatchAllWordForms = False
End With
```

Using MS-DOS features on a PC running WIN_ME, a batch file was created that copies all the WML(S) and PHP pages into one large single text file. Then, some search and replace operations are needed to ensure that all attributes are spell-checked, too. Finally, the spell-checker of MS-Word was used to correct the compiled large text document, but the errors were corrected simultaneously in the single WML(S) resp. PHP files, as this procedure is much easier and faster than de-compiling the large text document.

Summarising all the problems mentioned in this section, we finally had to give up the plan to provide a smart display of text on the R380s. The remaining problem was how to prepare graphic material for the R380s.

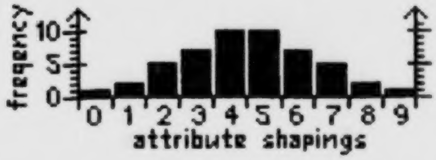
WML does not support any of the graphics formats known from the web but only a special bitmap format called WBMP (wireless bitmap), which only allows to show b&w (black&white) pictures. Thus a conversion procedure had to be used, we chose the on-line converter available at http://www.teraflops.com/wbmp/ to convert b&w graphics to the WBMP format. As the screen size of the R380s is approximately 330x95 pixels, the annotations of a graph had to be kept small to leave enough space for the graph itself. We found that a text height of 5 pixels would be enough to be able to read it, but none of our graphics programs produces convenient text output with that height, as can be seen from the following figure.


11: The quick brown fox jumps over the lazy dog
9: The quick brown fox jumps over the lazy dog
8: The quick brown fox jumps over the lazy dog
7: The quick brown fox jumps over the lazy dog
6: The quick brown fox jumps over the lazy dog
5: The quick brown fox jumps over the lazy dog
7: The quick brown
6: The quick brown fo>
5: The quick brown fox jumps

(a) (b)

Figure 2-9: How text output in MS-Windows depends on pixel height (enlarged!)

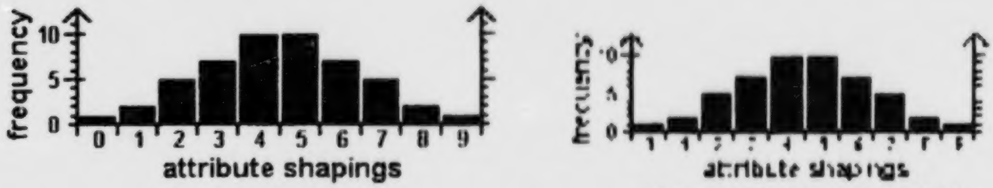
From fig. 2-9 it is obvious that a font size below 6 pixels leads to unacceptable results, but if the letters are corrected manually, a size of 5 pixels is the smallest readable one, as can be seen from the following figure.



size of original graph: 127x47 pixels WxH (200%)

Figure 2-10: Chart with 5 pixel font manually optimised (scale as in 2-9b)

Another problem is the creation of the small graphics. Usually, there will be some large scale graphics produced in a spreadsheet or statistics program, which have to be shrunk to fit into the maximum screen size of the R380s. The histogram shown in fig. 2-10 serves as an example. The following figure demonstrates the result of automatically shrinking a graphic in any common graphics program.



(a) size: 297x111 pixels

(b) size: 125x47 pixels (200%)

Figure 2-11: Preparing graphic course material

If the page size in MS-Excel97 is set to DIN A4 landscape, i.e. 30x21cm^2, the top resp. bottom margins to 9cm, and the left resp. right margin to 9cm resp. 14cm, a drawing area of approx. 3x7cm^2 results, which is close to the screen size of the R380s. Using a font size of 8 resp. 10 pixels for the axis annotations, the graphics output looks like fig. 2-11a. It is a full screen graphics for the R380s and the information contained can be easily perceived. But in its shrunk version in fig. 2-11b, none of the scales and text elements can't be well perceived, so these graphics have to be reworked manually, the result is depicted in fig. 2-12. The problems are caused by tiny elements which completely vanish in the shrinking process. In former times smart technicians solved this kind of problem by overexposing the negatives of the slides that were to be shown at conferences, e.g. It seems that there is no such smart digital image filter at the moment.

Using this technique is very time consuming and ineffective but makes it possible to show several graphs on the display of the R380s simultaneously, as it is necessary for explaining sophisticated differences between the graphs for deep understanding.

The same procedures as mentioned for graphics had to be applied to create the mathematical formulae as there are no corresponding WML tags. For some symbols UNICODE entities could have been used, but as nested tables aren't supported by WML, no complicated layout structure could have been created. So we decided to use the MS-Word formula editor to create the desired formulae, then exported the MS-Word document to HTML format, and finally converted the GIF-graphics created by this process to WBMP.

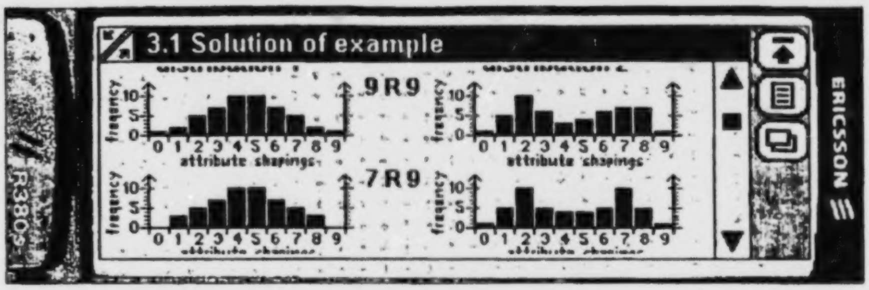


Figure 2-12: Small-multiple kind of graphics on the R380s (IDE 3.11 browser)

But all our efforts did not convince the students taking part in the pre-test phase of the courseware of the R380s being a proper device for mobile learning. So we decided to offer a version encoded in HTML, too, and to produce it by converting the content from WML to HTML using the same strategy as for spell-checking.

2.1.3 Converting content from WML to HTML

The procedure of how to search and replace things in the large text document compiled from all the small files containing the WML(S) resp. PHP content was developed on the fly, the following lines (entries for search&replace in MS-Word97) showing the first few steps:

1a) The WML-DTD and <wml> tag are cancelled (replaced by an empty string):

```
<?xml version="1.0"?>^a<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">^a<wml>^a
```

1b) The </wml> tag is cancelled (replaced by an empty string)

2a) The <card> tag marks the beginning of a page, therefore the HTML-DTD is inserted here:

`<card` is replaced by (the comment line serves for listing the file name later-on)

```
^a^a<!--  -->^a<!doctype html public "-//w3c//dtd html 3.2 transitional//en">^a<html><head>^a<meta http-equiv="content-type" content="text/html; charset=iso-8859-1">^a
```

2b) The </card> tag marks the end of a page, therefore the corresponding HTML tags are inserted:

`</card>` is replaced by `</body></html>`

3a) The id attribute of a WML card is re-defined as meta tag for HTML:

`id="` is replaced by `<meta name="description" content="`

3b) The title attribute of a WML card is re-defined as meta tag for HTML:

`title="` is replaced by `>^a<title>`

3c) Define end of meta content and beginning of the body of the HTML page:

`">` is replaced only in the line containing <title> by:

```
</title></head>^a<body text="#000000" bgcolor="#CCFFCC" link="#0000FF"
vlink="#004080" alink="#FF0000" background="lightblue.gif">^a
```

4) Convert for proper file extensions:

`.wml`	is replaced by	`.html`
`.wmls`	is replaced by	`.js`
`.wbmp`	is replaced by	`.gif`

and so forth and so on.

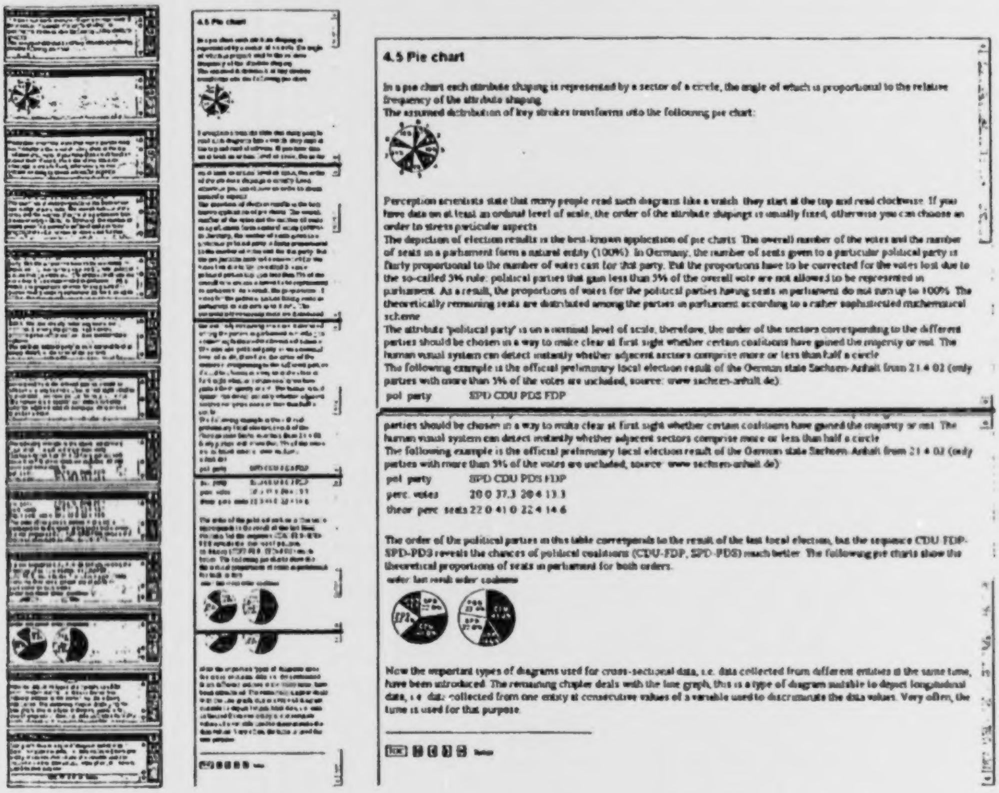
While converting text, graphs (which mostly had been created as GIF files and thus could be directly used) and even tables was more or less easy, adapting the interactive elements caused a lot of manual work. Due to the fact that many people have switched off JavaScript resp. ActiveScripting for security reasons, server side scripting (PHP) was chosen to replace the WMLS elements.

When looking at the first converted pages, the title bar we were used to from the WAP browser of the R380s was missing; the title is shown in the top bar of the web browser window, but it is much smaller with respect to the text size and in a much less pronounced position than in the WAP browser. So we decided to add a leading line to the converted HTML files displaying the title in a layout different from the text and we chose CSS for formatting.

The following figure shows the layout of a page in WML on the R380s and in HTML on a typical PDA and a 14" PC monitor; in the figures we have chosen to leave the bottom text line of one screen shot visible as top line in the consecutive screen shot. For WML, the screen size of the R380s forces the learning person to scroll excessively, i.e. twelve times, on the PDA four times and on the PC monitor only once. The content of the depicted chapter of the STAT course well fits on one and a half DIN A4 pages.

The conversion from WML to HTML wasn't too complicated, but especially the interactive elements and tables required much manual work. For the complete courseware, which comprises about 80 WML pages, it took about 16 hours to develop the macro, and for every converted page about 10 minutes were needed for final corrections.

Though taking the course on a PDA may be more convenient than on a R380s, the material is still static, i.e. it cannot be personalised by adding remarks, sketches or whatever a learner may to add because she or he is used to it from conventional pencil-paper learning. There are document formats which allow for adding some kinds of remarks, but they were designed for an electronic version of books, i.e. for reading from the first to the last page.



4.5 Pie chart

In a pie chart each attribute shaping is represented by a sector of a circle, the angle of which is proportional to the relative frequency of the attribute shaping.
The assumed distribution of key strokes transforms into the following pie chart:

Perception scientists state that many people read such diagrams like a watch: they start at the top and read clockwise. If you have data on at least an ordinal level of scale, the order of the attribute shapings is usually fixed, otherwise you can choose an order to stress particular aspects.
The depiction of election results is the best-known application of pie charts. The overall number of the votes and the number of seats in a parliament form a natural entity (100%). In Germany, the number of seats given to a particular political party is fairly proportional to the number of votes cast for that party. But the proportions have to be corrected for the votes lost due to the so-called 5% rule: political parties that gain less than 5% of the overall vote are not allowed to be represented in parliament. As a result, the proportions of votes for the political parties having seats in parliament do not sum up to 100%. The theoretically remaining seats are distributed among the parties in parliament according to a rather sophisticated mathematical scheme.
The attribute 'political party' is on a nominal level of scale, therefore, the order of the sectors corresponding to the different parties should be chosen in a way to make clear at first sight whether certain coalitions have gained the majority or not. The human visual system can detect instantly whether adjacent sectors comprise more or less than half a circle.
The following example is the official preliminary local election result of the German state Sachsen-Anhalt from 21.4.02 (only parties with more than 5% of the votes are included, source: www.sachsen-anhalt.de):
pol. party SPD CDU PDS FDP

parties should be chosen in a way to make clear at first sight whether certain coalitions have gained the majority or not. The human visual system can detect instantly whether adjacent sectors comprise more or less than half a circle.
The following example is the official preliminary local election result of the German state Sachsen-Anhalt from 21.4.02 (only parties with more than 5% of the votes are included, source: www.sachsen-anhalt.de):

pol. party	SPD	CDU	PDS	FDP
perc. votes	20.0	37.3	20.4	13.3
theor. perc. seats	22.0	41.0	22.4	14.6

The order of the political parties in this table corresponds to the result of the last local election, but the sequence CDU-FDP-SPD-PDS reveals the chances of political coalitions (CDU-FDP, SPD-PDS) much better. The following pie charts show the theoretical proportions of seats in parliament for both orders.
order last result order coalitions

Now the important types of diagrams used for cross-sectional data, i.e. data collected from different entities at the same time, have been introduced. The remaining chapter deals with the line graph; this is a type of diagram suitable to depict longitudinal data, i.e. data collected from one entity at consecutive values of a variable used to discriminate the data values. Very often, the time is used for that purpose.

(a) (b) (c)

Figure 2-13: Layout of courseware on different devices (screenshots)
(a) WML on R380s (IDE 3.11 browser) ; scrolling: 1x
(b) HTML on PDA (IE) ; scrolling: 4x
(c) HTML on 14" PC monitor (IE) ; scrolling: 12x

2.1.4 Converting content from HTML to eBook formats

We tried out two different versions of eBooks, MS-Reader and MobiPocket-Reader. Both versions require the content to be in HTML format, and the MobiPocket reader additionally requires the images to be JPEGs; for that, we used the batch conversion capability of our image processing software and a DOS batch file for replacing the string ".gif" by ".jpg" in all the HTML files.

The fundamental difference between the concept of an eBook and that of usual material for the web is the manner of reading through the material: the concept of an eBook is optimal for reading a novel, i.e. starting on the first page and then reading through all pages successively, whereas usual web pages allow for a more complex kind of reading, which is characterised by frequently using links to collect information on a specific subject presented on different HTML pages . Thus, early versions of ebooks required the material to consist of only a single HTML page.

Both eBook formats tested allow for several HTML pages and support links from one page to another, whereas external links aren't supported. Thus, the basic structure of the material formatted in HTML could be kept unchanged. So why should a content provider consider publishing complex material in form of an eBook, if the reading is more restricted than for usual web pages? Because readers can add personal remarks, drawings and bookmarks to the material! The following figures show the process of creating MS-Reader and MobiPocket ebooks.

Though not stated in the manual, all the graphics had to be formatted as JPEGs for the MobiPocket reader, but they need not be included in the project file, whereas the GIF format could be maintained for the ReaderWorks format, but all image files had to be included in the project file. On top of that, MobiPocket publisher did change the header of the HTML files without asking or even notifying the program user. The beginning of the English version of the TOC page originally reads:

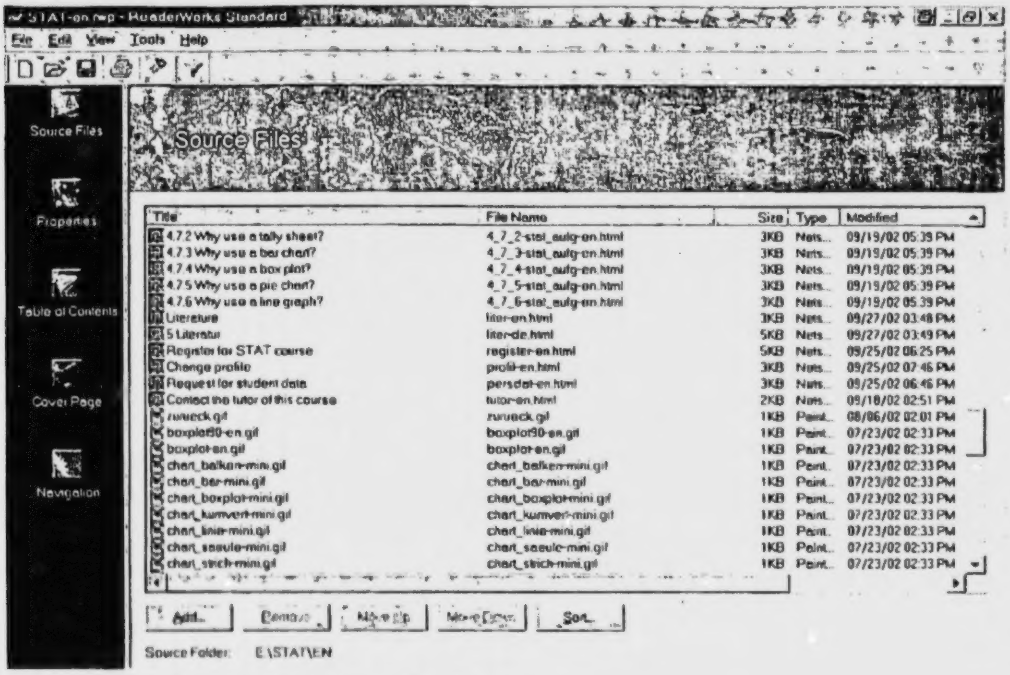
```
<!-- invz-en.html -->
<!doctype html public "-//w3c//dtd html 3.2 transitional//en">
<html><head>
<style type="text/css">
```

and is changed to

```
<?xml version="1.0" encoding="iso-8859-1"?><!DOCTYPE f SYSTEM
   "C:\PROGRAMME\MOBIPOCKET.COM\MOBIPOCKET PUBLISHER 3.0\htmlentities.dtd">
<html ><head >
<style type="text/css" >.
```

Especially annoying is the deletion of the comment line keeping the file name.

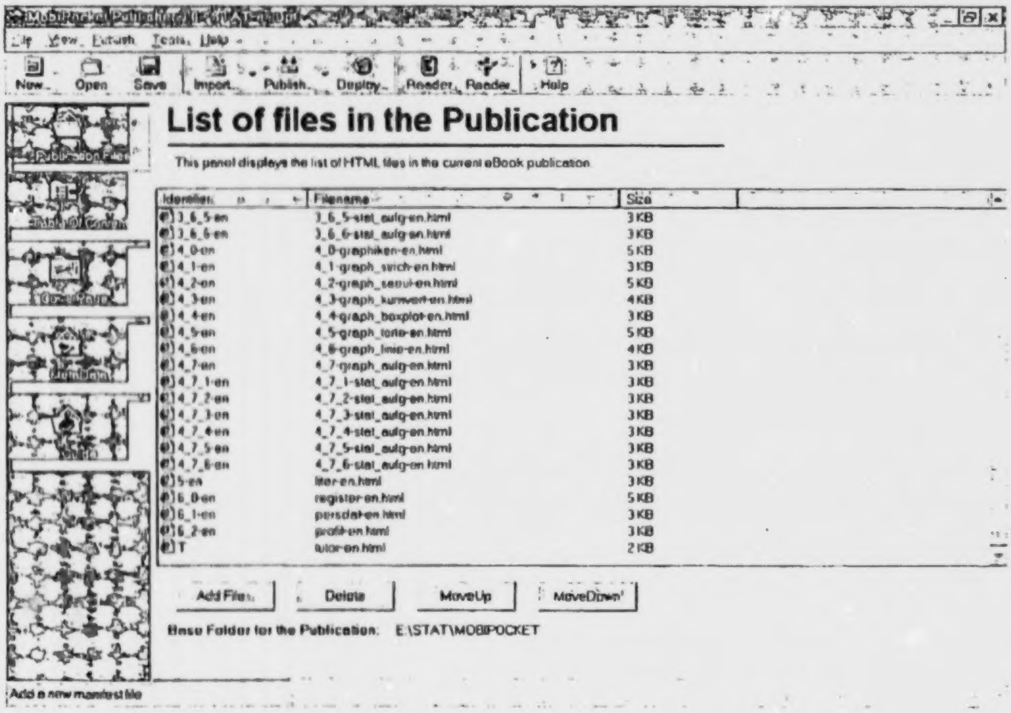
Both eBook compilers exactly check the internal links, i.e. those not starting with 'http://', of all HTML files within the project and then compile a single large eBook file in which the content of the HTML files is presented as provided by the order of the HTML files in the project file. The external links need not be removed from the HTML files but cannot be reached from within the eBooks.


STAT-en.rwp - ReaderWorks Standard
File Edit View Tools Help
Source Files
Properties
Table of Contents
Cover Page
Navigation
Source Files
Add...
Remove
Move Up
Move Down
Sort...

Title	File Name	Size	Type	Modified
4.7.2 Why use a tally sheet?	4_7_2-stat_aufg-en.html	3KB	Nets...	09/19/02 05:39 PM
4.7.3 Why use a bar chart?	4_7_3-stat_aufg-en.html	3KB	Nets...	09/19/02 05:39 PM
4.7.4 Why use a box plot?	4_7_4-stat_aufg-en.html	3KB	Nets...	09/19/02 05:39 PM
4.7.5 Why use a pie chart?	4_7_5-stat_aufg-en.html	3KB	Nets...	09/19/02 05:39 PM
4.7.6 Why use a line graph?	4_7_6-stat_aufg-en.html	3KB	Nets...	09/19/02 05:39 PM
Literature	liter-en.html	3KB	Nets...	09/27/02 03:48 PM
5 Literatur	liter-de.html	5KB	Nets...	09/27/02 03:49 PM
Register for STAT course	register-en.html	5KB	Nets...	09/25/02 06:25 PM
Change profile	profil-en.html	3KB	Nets...	09/25/02 07:46 PM
Request for student data	persdat-en.html	3KB	Nets...	09/25/02 06:46 PM
Contact the tutor of this course	tutor-en.html	2KB	Nets...	09/18/02 02:51 PM
zurueck.gif	zurueck.gif	1KB	Paint...	08/06/02 02:01 PM
boxplot90-en.gif	boxplot90-en.gif	1KB	Paint...	07/23/02 02:33 PM
boxplot-en.gif	boxplot-en.gif	1KB	Paint...	07/23/02 02:33 PM
chart_balken-mini.gif	chart_balken-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_bar-mini.gif	chart_bar-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_boxplot-mini.gif	chart_boxplot-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_kumvert-mini.gif	chart_kumvert-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_linie-mini.gif	chart_linie-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_saeule-mini.gif	chart_saeule-mini.gif	1KB	Paint...	07/23/02 02:33 PM
chart_strich-mini.gif	chart_strich-mini.gif	1KB	Paint...	07/23/02 02:33 PM

Source Folder: E:\STAT\EN

Figure 2-14a: Creation of a ReaderWorks project


File View Publish Tools Help
New...
Open
Save
Import...
Publish...
Deploy...
Reader...
Reader...
Help
Publication Files
Table of Contents
Cover Page
MetaData
Add Files...
Delete
MoveUp
MoveDown

List of files in the Publication

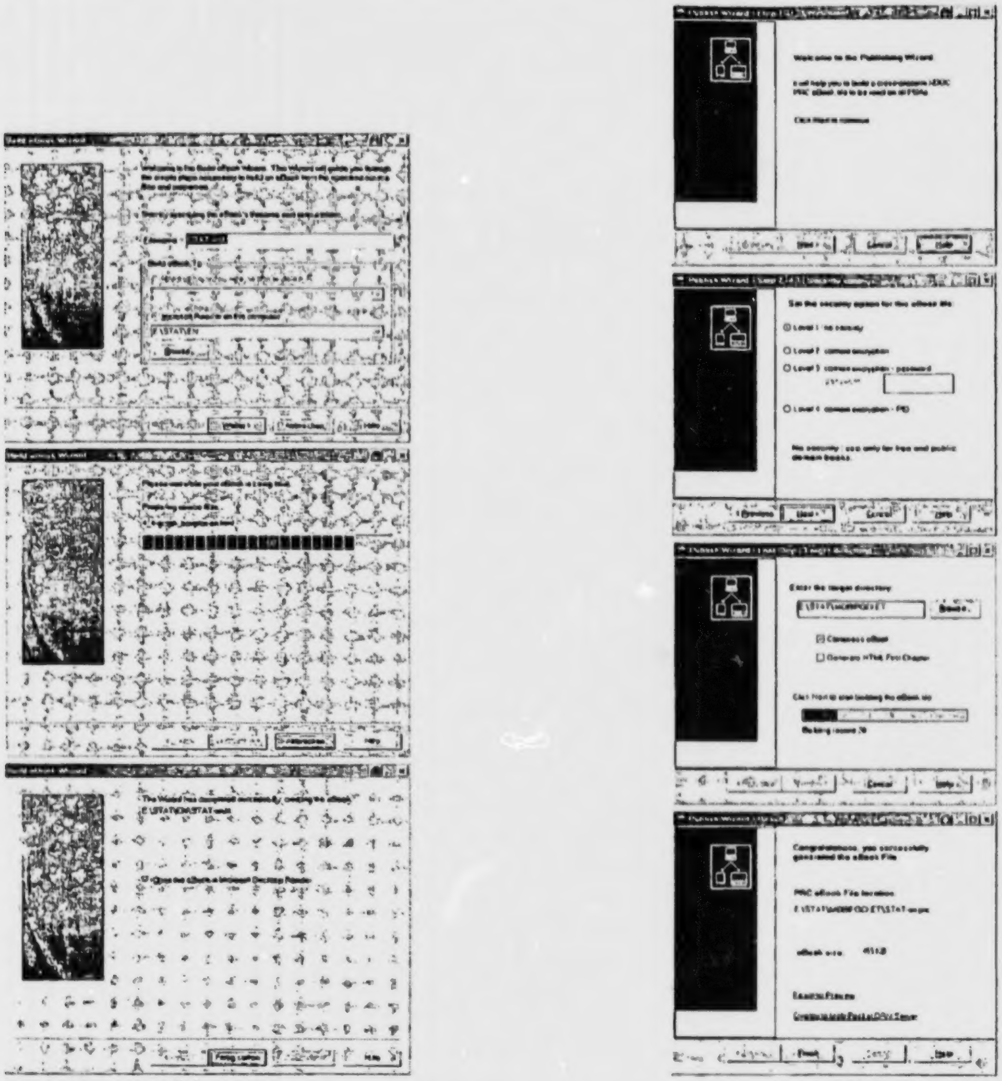
This panel displays the list of HTML files in the current eBook publication

Identifier	Filename	Size
3_6_5-en	3_6_5-stat_aufg-en.html	3 KB
3_6_6-en	3_6_6-stat_aufg-en.html	3 KB
4_0-en	4_0-graphiken-en.html	5 KB
4_1-en	4_1-graph_strich-en.html	3 KB
4_2-en	4_2-graph_saeul-en.html	5 KB
4_3-en	4_3-graph_kumvert-en.html	4 KB
4_4-en	4_4-graph_boxplot-en.html	3 KB
4_5-en	4_5-graph_torte-en.html	5 KB
4_6-en	4_6-graph_linie-en.html	4 KB
4_7-en	4_7-graph_aufg-en.html	3 KB
4_7_1-en	4_7_1-stat_aufg-en.html	3 KB
4_7_2-en	4_7_2-stat_aufg-en.html	3 KB
4_7_3-en	4_7_3-stat_aufg-en.html	3 KB
4_7_4-en	4_7_4-stat_aufg-en.html	3 KB
4_7_5-en	4_7_5-stat_aufg-en.html	3 KB
4_7_6-en	4_7_6-stat_aufg-en.html	3 KB
5-en	liter-en.html	3 KB
6_0-en	register-en.html	5 KB
6_1-en	persdat-en.html	3 KB
6_2-en	profil-en.html	3 KB
T	tutor-en.html	2 KB

Base Folder for the Publication: E:\STAT\MOBIPOCKET

Add a new manifest file

Figure 2-14b: Creation of a MobiPocket project

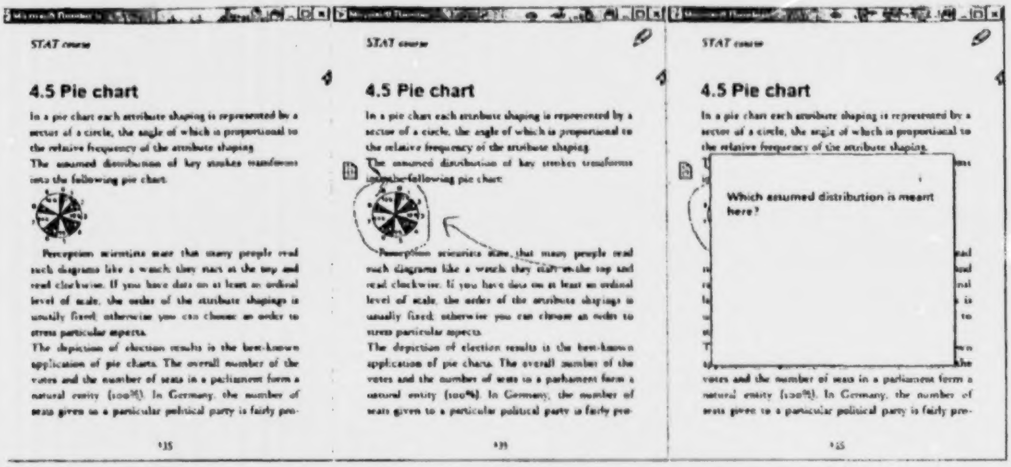


(a) (b)

Figure 2-15: Steps to create an eBook:
(a) ReaderWorks for MS-Reader LIT format
(b) MobiPocket for MobiPocket PRC format

As there is no possibility to send in exercises or questions to the tutor, e.g., why may eBooks nevertheless be useful?

Because it is possible to add personal remarks to the document and store them with the eBook. The following figures give a clue of what is meant, the MS-Reader serves as example.



STAT course

4.5 Pie chart

In a pie chart each attribute shaping is represented by a sector of a circle, the angle of which is proportional to the relative frequency of the attribute shaping.
The assumed distribution of key strokes transforms into the following pie chart.

Perception scientists state that many people read such diagrams like a watch: they start at the top and read clockwise. If you have data on at least an ordinal level of scale, the order of the attribute shapings is usually fixed, otherwise you can choose an order to stress particular aspects.
The depiction of election results is the best-known application of pie charts. The overall number of the votes and the number of seats in a parliament form a natural entity (100%). In Germany, the number of seats given to a particular political party is fairly pro-

Which assumed distribution is meant here?

(a) (b) (c)

Figure 2-16: Adding personal remarks to an eBook (screenshots from PC monitor)
(a) Bookmark (indicated by red arrow)
(b) Sketch (indicated by pencil symbol)
(c) Comment (indicated by page symbol)

This feature really adds value to the document format as no other program has to be used simultaneously to create or view the personal remarks. And ideally, it should be possible to share these remarks with others, but that's a dream today.

This section dealt with the description of how to provide mobile content, the next one describes how to provide mobile student support services like administration and tutoring, e.g.

2.2 Providing mobile student support services

For mobile services, the usual media letter and fax will be replaced by some other kind of messages. In principle, the R380s supports three kinds of messages: SMS, email and fax. As email and fax are quite expensive as compared to SMS, and text input on the R380s is not as convenient as using a PC keyboard, sending and receiving SMS will be the rule.

2.2.1 SMS messages

Dealing with SMS on the R380s is simple, only the folder which keeps unsent SMS is unintuitively hidden in a sub-menu. The R380s virtual keyboard provides many characters (Unicodes!) common mobile phones cannot display, but for straight text SMS there are no problems. And the R380s can send and receive linked SMS, i.e. messages aren't restricted to a length of 160 characters (if you send 230 characters, you are charged for 2 SMS).

Unfortunately, the providers of mobile networks started to charge for PC-written SMS in 2001. Thus, a service provider had to be contacted for providing a script controlled SMS service to the FeU. We have chosen the company NovelSoft (www.sms-wap.com) for that purpose. They provide scripts in any common scripting language which send SMS to mobile phones nearly all over the world on specific events. These events can be caused by manually starting a local script, but also from some activities on the web server, though in this case security is a crucial point because many people are waiting for others paying their SMS bill. For testing, we bought a package of 200 SMS at a price of 17cent each. For each SMS the sender, life time and priority class can be set individually. An error flag reports whether the SMS was sent successfully or not.

2.2.2 Administration services

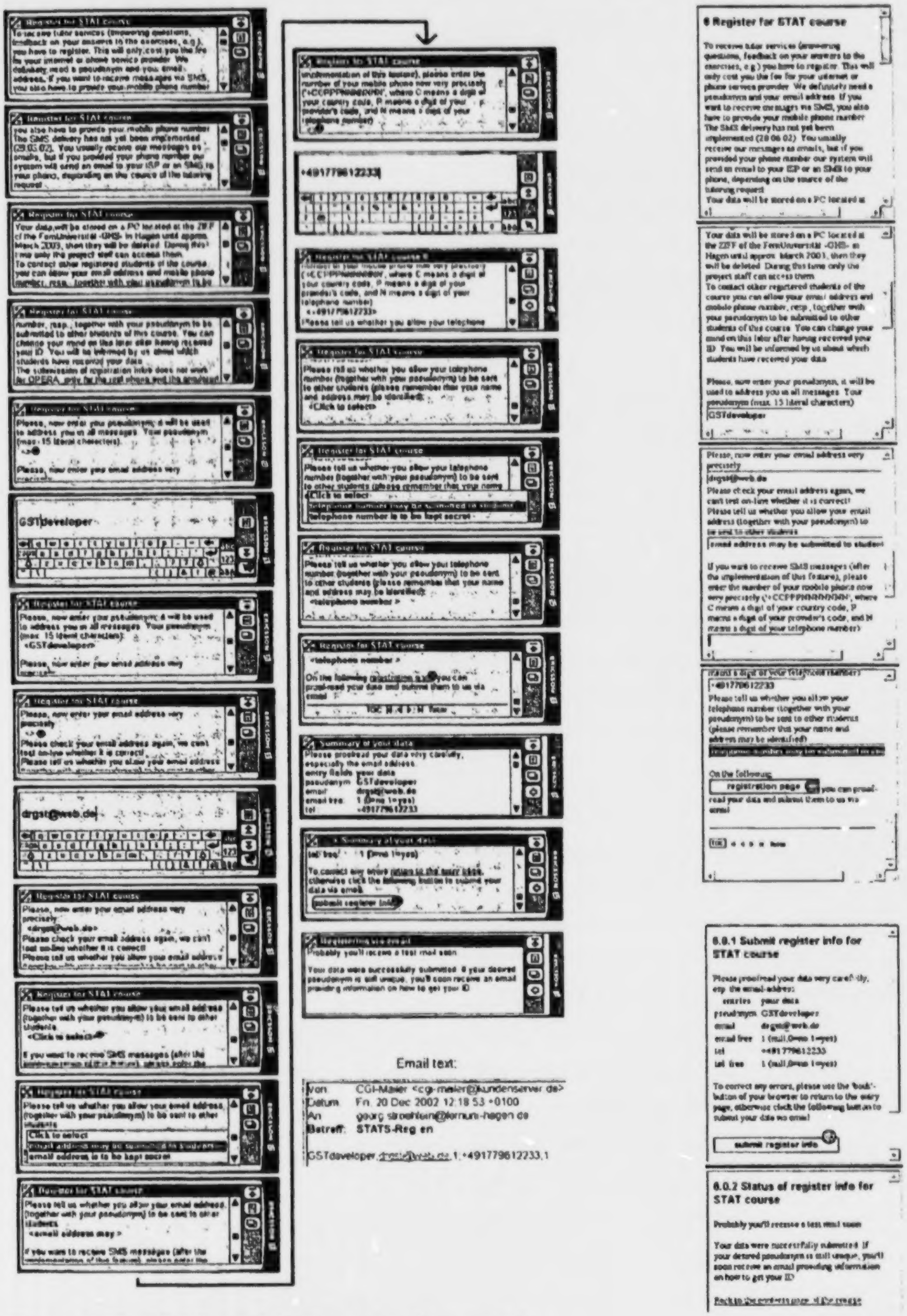
The following figures depict the mobile administration, tutoring and examination services implemented in the courseware. To prevent abuse, a test email/SMS scenario was chosen, but this has been judged to be illegal unwanted advertising in the meantime, so changes will have to be applied at this point. But it remains unclear at the moment how legal mobile registration services can be designed as only very few people have their own digital certificates.

If a person submits the registration information via WAP or HTTP, two automatically created emails are sent: one to the known address of the course administrator and another one to the email address submitted just before. If the latter email does not fail, the administrator is supposed to send a second email to this address when logged into the system next time. In this email it is explained why this confirmation email seems desirable and what action the recipient has to take to register for the course.

The registration procedure seems to be too complicated for convenient mobile use, and we doubt lawyers will accept the contracts formally made by clicking a button on such small screens like the R380s is equipped with and which only allow one additional sentence to be displayed simultaneously.

We decided that at least 5 parameters are necessary for mobile administration services: a username, the email address, the mobile phone number, and two flags that state whether a person allows the email address and/or phone number to be submitted to other course attendees. If access to the courseware is restricted, additionally a password would be required as 6^{th} parameter. As the FeU does not run a database server for public access and I wanted to sleep at night during the project we decided to design an email/SMS driven information exchange. In the next figure the registration service is shown as an example.

As can be seen from the procedure depicted in the following figures it is quite complicated to obey the rules made by chief data privacy officers. But if this wasn't a project but a registration for a real course for which people would be charged a considerable amount of money, these rules must strictly be obeyed.



Email text:

Von CGI-Maier <cgi-maier@kundenserver.de>
Datum Fri, 20 Dec 2002 12:18:53 +0100
An georg.stroehlein@fernuni-hagen.de
Betreff: STATS-Reg en

GSTdeveloper,drgst@web.de,1,+491779612233,1

6 Register for STAT course

To receive tutor services (answering questions, feedback on your answers to the exercises, e.g.) you have to register. This will only cost you the fee for your internet or phone service provider. We definitely need a pseudonym and your email address. If you want to receive messages via SMS, you also have to provide your mobile phone number. The SMS delivery has not yet been implemented (28.06.02). You usually receive our messages as emails, but if you provided your phone number our system will send an email to your ISP or an SMS to your phone, depending on the source of the tutoring request.

Your data will be stored on a PC located at the ZIFF of the FernUniversität -GHS- in Hagen until approx. March 2003, then they will be deleted. During this time only the project staff can access them.

To contact other registered students of the course you can allow your email address and mobile phone number, resp., together with your pseudonym to be submitted to other students of this course. You can change your mind on this later after having received your ID. You will be informed by us about which students have received your data.

Please, now enter your pseudonym, it will be used to address you in all messages. Your pseudonym (max. 15 literal characters)

GSTdeveloper

Please, now enter your email address very precisely

drgst@web.de

Please check your email address again, we can't test on-line whether it is correct!

Please tell us whether you allow your email address (together with your pseudonym) to be sent to other students

email address may be submitted to student

If you want to receive SMS messages (after the implementation of this feature), please enter the number of your mobile phone now very precisely ('+CCPPPNNNNNNN', where C means a digit of your country code, P means a digit of your provider's code, and N means a digit of your telephone number)

+491779612233

Please tell us whether you allow your telephone number (together with your pseudonym) to be sent to other students (please remember that your name and address may be identified)

telephone number may be submitted to stu

On the following registration page you can proof-read your data and submit them to us via email

6.0.1 Submit register info for STAT course

Please proofread your data very carefully, esp. the email-address:

entries	your data
pseudonym	GSTdeveloper
email	drgst@web.de
email free	1 (null,0=no 1=yes)
tel	+491779612233
tel free	1 (null,0=no 1=yes)

To correct any errors, please use the 'back'-button of your browser to return to the entry page, otherwise click the following button to submit your data via email!

submit register info

6.0.2 Status of register info for STAT course

Probably you'll receive a test mail soon

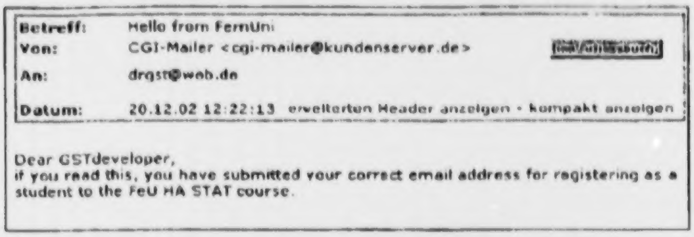
Your data were successfully submitted. If your desired pseudonym is still unique, you'll soon receive an email providing information on how to get your ID

Back to the contents page of the course

Figure 2-17a: Mobile registration procedure, part I

Left part: R380s and WML; right part: , PDA and HTML

BEST COPY AVAILABLE



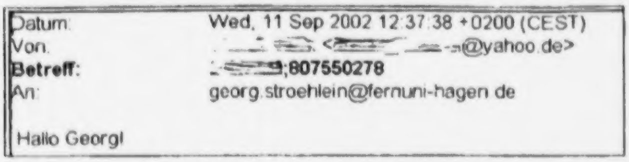
Betreff: Hello from FernUni
Von: CGI-Mailer <cgi-mailer@kundenserver.de>
An: drgst@web.de
Datum: 20.12.02 12:22:13 erweiterten Header anzeigen · kompakt anzeigen

Dear GSTdeveloper,
if you read this, you have submitted your correct email address for registering as a student to the FeU HA STAT course.

Figure 2-17b: Mobile registration procedure, part II

Guten Tag,	Hello!
dies ist eine automatisch generierte Antwort-Email.	This is an automatically generated email.
Unter Ihrer Emailadresse ist eine Registrierungs-Email für den Kurs zur "Einführung in die deskriptive Statistik" im Projekt "from e-learning to m-learning" bei uns eingetroffen.	We have received a registration email providing your email address and concerning the course 'Introduction to descriptive statistics' which is held within the project 'from e-learning to m-learning'.
Um möglichem Mißbrauch vorzubeugen, bitten wir Sie, im Fall einer erwünschten Registrierung auf diese Email folgendermaßen zu antworten: im Betreff der Antwort nennen Sie bitte abermals das von Ihnen gewünschte Pseudonym, gefolgt von einem Semikolon (";"), gefolgt von der Zahl "nnnnnnnnn"; der Text der Antwort-Email kann leer bleiben, braucht es aber nicht.	To prevent abuse, we kindly ask you answer this email if you indeed want to register. The 'subject' field of your answer has to contain the pseudonym already submitted to us, followed by a semicolon (';'), followed by the 12 digit number 'nnnnnnnnnnnn'. The 'body' field may be left empty.
Wenn Ihre Antwort-Email bei uns eingetroffen und von unserem System als korrekt eingestuft und verarbeitet worden ist, erhalten Sie an diese Emailadresse eine Email mit Ihrer Matrikelnummer und der Bestätigung Ihres Pseudonyms bzw. ggf. eines Vorschlages für ein solches, falls das gewünschte schon vergeben sein sollte.	After your answer email has reached us, has been processed and thereby qualified as correct, you will receive an email to this account that contains your identification number and the confirmation of your desired pseudonym or a proposal for another one, if it has been assigned already.
Als Absender dieser Email ist die Adresse des für den Kurs zuständigen Tutors --und zur Zeit auch Administrators -- angegeben.	As 'sender' of this email the address of the tutor of the STAT course, who by now is the administrator as well, is stated.
Mit freundlichen Grüßen aus Hagen	Best regards from Hagen
Georg Ströhlein	Georg Ströhlein

Figure 2-17c: Mobile registration procedure, part III



Datum: Wed, 11 Sep 2002 12:37:38 +0200 (CEST)
Von: [redacted]@yahoo.de>
Betreff: [redacted];807550278
An: georg.stroehlein@fernuni-hagen.de

Hallo Georg!

Figure 2-17d: Mobile registration procedure, part IV

Guten Tag,	Hello!
dies ist eine automatisch generierte Antwort-Email.	This is an automatically generated email.
Der erfolgreiche Email-Austausch mit diesem Mail-Konto hat nun die --sicherlich erfreuliche-- Konsequenz, daß Sie als Teilnehmer des Kurses "Einführung in die deskriptive Statistik" für mobile Endgräte registriert sind. Ihre 12-stellige Matrikelnummer (ID, IDNO, oder wie auch immer diese im Kurs heißt) lautet: "269669584642".	The successful exchange of emails with this account now has the --surely pleasant-- consequence that you are registered as attendee of the course 'Introduction to descriptive statistics' which is designed for mobile devices. Your 12 digit identification number (ID, IDNO or what else it is called in the courseware) reads: "269669584642".
Sie brauchen diese Nummer, um sich als Absender von Kurs-Mails (Aufgaben, Statusänderung usw.) zu identifizieren.	You need this number to identify yourself as sender of mails related to the course (exercises, change of profile, etc.).
Ihr gewünschtes Pseudonym war noch frei; es wird hier nicht genannt, um "Mitlesern" Manipulationen zu erschweren.	The pseudonym you chose was unique, it isn't mentioned here to challenge "coreaders".
Bitte benutzen Sie für Anfragen zum Kurs --soweit eben möglich-- das in der HTML- und WAP-Version vorhandene Mail-dem-Tutor-System; dies gestattet auf unserer Seite eine bestmögliche Auswertung, gerade auch im Sinne von Qualitätssicherung. In Antworten auf diese Emails werden Sie mit Ihrem Pseudonym angesprochen werden.	Please use the email-the-tutor system provided by both the HTML and WML courseware as often as possible; this assures an optimal processing in our system and even enables some evaluation and quality management. In the answer emails you will be addressed by your pseudonym.
Wir wünschen Ihnen viel Spaß und Erfolg beim Kurs!	We wish you much fun and success with our course.
Mit freundlichen Grüßen aus Hagen	Best regards from Hagen
Georg Ströhlein	Georg Ströhlein

Figure 2-17e: Mobile registration procedure, part V

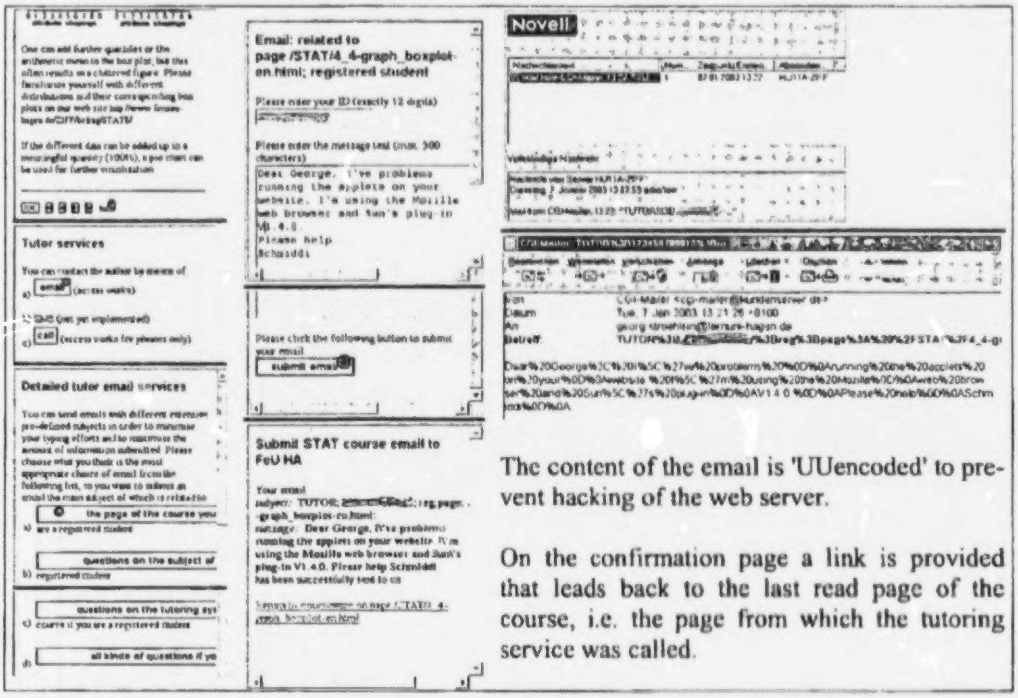
As can be seen from the figures, obeying the rules leads to a lot of text that has to be read from small screens. We therefore think it does not make much sense to try to create a mobile version of this kind of administration services. This statement obviously does not hold true for tutoring.

2.2.3 Tutoring services

Generally speaking, by tutoring services we mean any communication between a student and all those persons working for the provider of the course who are assigned to it in some way. This will usually be a set of different people, i.e. the tutor, the webmaster, the postmaster and some technicians who are experts in accessing mobile content, e.g.

As text input is tedious on the R380s, we decided to offer a pre-selection of the main subject of the message to be sent to the FeU by email, so that the students need not keep track of all the relevant email addresses or phone numbers. This procedure also reduces the costs of tutoring services for the students significantly, because they need not enter the recipient and the subject.

For easy access, a tutor button appears in the navigation bar at the bottom of each page. If the email is related to the content of a page, the file name is included in the 'subject' field to achieve maximum reliability of the information sent to the provider of the course and to minimise the typing efforts of the students. The pre-selection leads to pre-defined entries in the 'to' and 'subject' field of the email, so that a script running at the FeU can discriminate to which person the email is to be forwarded, the tutor or administrator, e.g. The email is created by a script running on the web server on which the course is kept, no matter what version of the course is actually viewed, but of course the eBook versions are excluded at this point. The following figure depicts the procedure.


Tutor services
email
call
Detailed tutor email services
the page of the course you
questions on the subject of
questions on the tutoring sys
all kinds of questions if yo
submit email
Novell

Email: related to page /STAT/4_4-graph_boxplot-en.html; registered student

Please enter your ID (exactly 12 digits)

[redacted]

Please enter the message text (max. 300 characters)

```
Dear George, I've problems
running the applets on your
website. I'm using the Mozilla
web browser and Sun's plug-in
V1.4.0.
Please help
Schmiddi
```

Please click the following button to submit your email

Submit STAT course email to FeU HA

Your email
subject: TUTOR; [redacted]; reg page: 4-graph_boxplot-en.html;
message: Dear George, I've problems running the applets on your website. I'm using the Mozilla web browser and Sun's plug-in V1.4.0. Please help Schmiddi
has been successfully sent to us

Return to coursepage on page /STAT/4_4-graph_boxplot-en.html

Datum: Tue, 7 Jan 2003 13:21:26 +0100

Betreff: TUTOR%3A [redacted] %3Dreg%3Dpage%3A%20%2FSTAT%2F4_4-g

The content of the email is 'UUencoded' to prevent hacking of the web server.

On the confirmation page a link is provided that leads back to the last read page of the course, i.e. the page from which the tutoring service was called.

Figure 2-18: The tutoring services from student to tutor

BEST COPY AVAILABLE

For the sake of simplicity, only the PDA version is shown. For the R380s, the text is all the same, but much more scrolling is involved, as can be seen from the analogous registration procedure depicted in fig. 2-17a.

2.2.4 Communication services

The only way a content provider like a university can enhance the communication between its employees and the students is to provide a database containing the relevant email addresses and phone numbers. Depending on the mandatory level of data privacy accessing these data will be more or less restricted and controlled.

We don't think SMS push services will be frequently used by a content provider for mobile learning purposes. SMS are a proper tool if the recipient is to be informed quickly, but they only make sense if the recipient has a fair chance to react before the content of the message is out-dated. Thus, for most appointments an email sent out in good time will make much more sense and is much cheaper than an SMS.

2.2.5 Self-examination services

At the end of all chapters there are some simple exercises presented as multiple-choice questions that are meant to be solved by the students on their own. Registered students can send in the exercises to the tutor for correction. We prefer this scenario because no publicly available database services are necessary and we don't want to give the students the possibility to fool themselves by looking at the source code of scripts included in the content for checking the solution. The figures in sect. 2.1.2 give an example of the exercises.

As the smartphone R380s for which the courseware was developed cannot run two programs simultaneously, i.e. browser and calculator, and we didn't want to check the level of mental arithmetic of the students, all exercises were designed to be solvable without the need of calculations. The problems posed and solved as examples within the courseware are more complex, and the students using PDAs can even download the files containing all the material needed to redo all calculations presented (and their own, of course).

The question of how to optimally let the students know how good their skills are is still a crucial point in pedagogical concepts of (distance) study and will surely need further investigation. And to find those problems that allow for a fair discrimination between all levels of skills is an important part of the art of teaching.

2.3 The client side

In this section the technical aspects of the mobile devices under consideration are described, the practice of mobile learning is outlined in the next chapter. As mentioned earlier, the smartphone ERICSSON R380s is used to access WML-formatted content, whereas the PDAs CASIO Cassiopeia E-200G, PSION 5mxPRO and PALM m515 together with the mobile

40

phone NOKIA 6310i are used to access HTML-formatted content. Only in the latter case the fast data transmission technique GPRS could be tested.

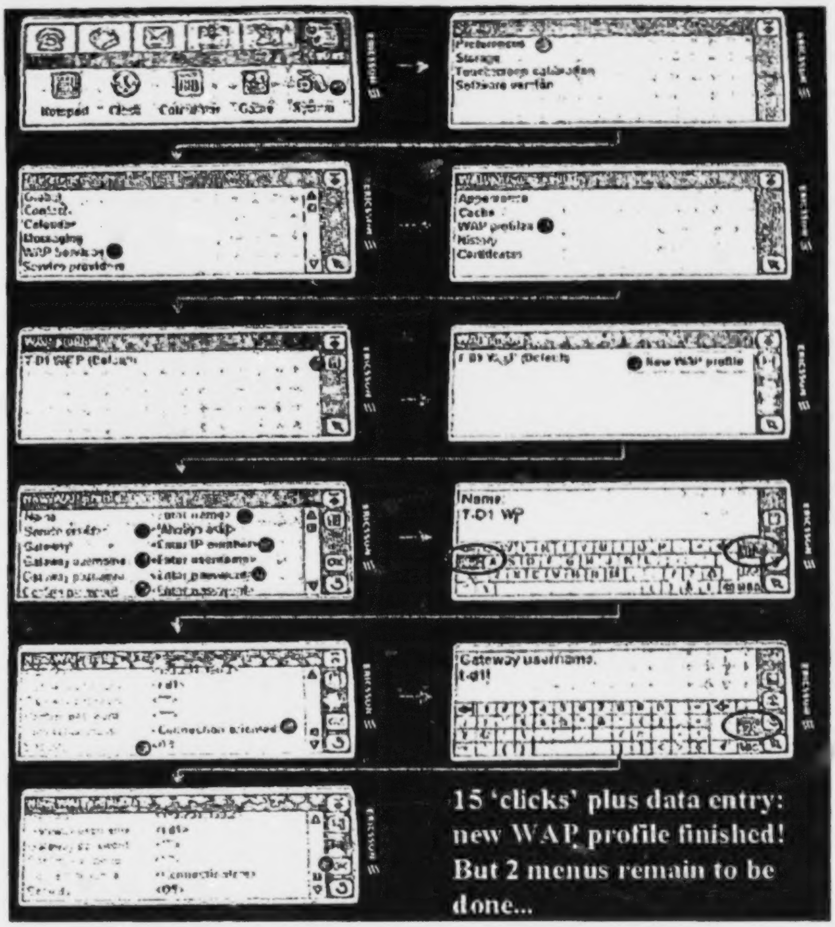
For the purpose of on-line reading complex content, the GPRS (not HSCSD!!) technique is recommended, because only the amount of data transferred to and from the phone is billed and not the on-line time. And thus the very annoying dis- and re-connection procedure implemented in the R380s' WAP browser (using CSD) for saving costs is avoided. For download of content that is read off-line later HSCSD can be useful, too. In Germany, it depends on the mobile services provider which enhanced technique is available.

Concluding, the R380s had to be configured for using the WAP protocol to access WML-formatted content and the PDAs had to be configured for using the mobile internet gateway of our service provider and for using the mobile phone as radio modem for GPRS data transmission.

2.3.1 Smartphone ERICSSON R380s

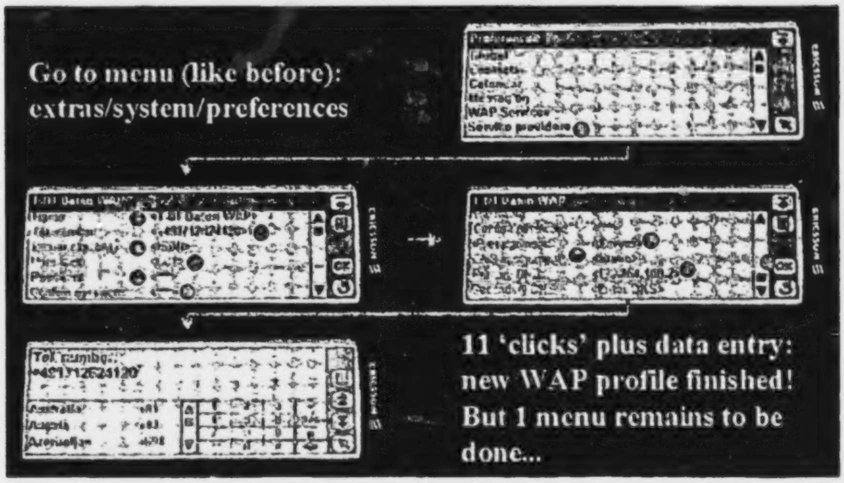
To configure the R380s for successfully connecting to a WAP provider, there are basically two different ways: get a configuration SMS from the WAP provider and store it in the phone and be ready for WAP or setting all parameters manually, which obviously is much more laborious. It seems that only few R380s phones have been sold in Germany and thus none of the WAP providers offers the convenient SMS configuration procedure. The following figures describe the WAP rally that results during the manual configuration procedure, the three main stages are the WAP profile settings, the WAP service provider settings and the WAP browser bookmark creation (please count the 'clicks', i.e. the dots ○ in the pictures...).

All necessary parameters can be found on the web site of T-D1, i.e. our mobile services provider, but the important features concerned with WAP security are more or less hidden in the small print. For example, the settings for the parameters 'Connection mode' and 'Security' can't be chosen arbitrarily, though this impression is caused by the WAP profile menu of the R380s. And it depends on these very entries whether it is possible or not to add the phone number of the tutor to the phonebook of the R380s by clicking a button on a properly designed WML page, e.g.



15 'clicks' plus data entry: new WAP profile finished! But 2 menus remain to be done...

Figure 2-19: Configuration procedure to define a new WAP profile



Go to menu (like before): extras/system/preferences

11 'clicks' plus data entry: new WAP profile finished! But 1 menu remains to be done...

Figure 2-20: Configuration procedure to define a new WAP service provider

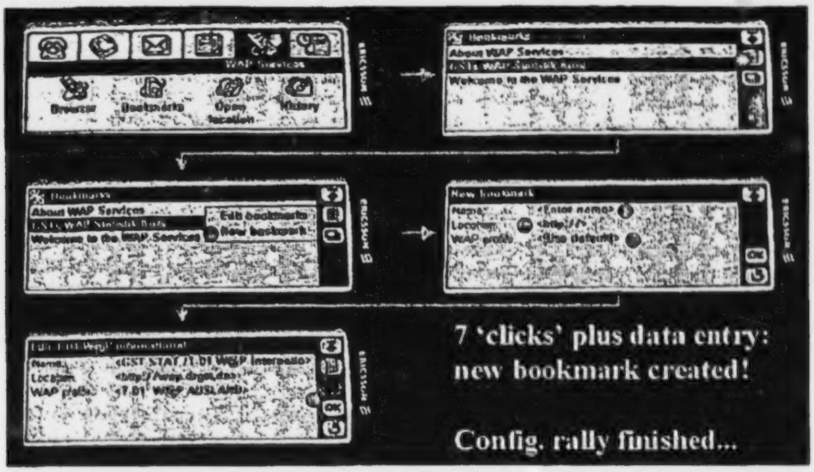

WAP Services
Browser
Bookmarks
Open location
History
Bookmarks
About WAP Services
Welcome to the WAP Services
Edit bookmarks
New bookmark
New bookmark
Name
Location
WAP profile
7 'clicks' plus data entry:
new bookmark created!
Config. rally finished...

Figure 2-21: Configuration procedure to define a new WAP bookmark

The whole process of getting the R380s to work properly for browsing WML content on the internet seems to be much too complicated for the average user of mobile phones and reminds the author to those early times of the internet when figuring out the correct 'AT commands' for 2400 Baud modems was the most rewarded late night activity. But the configuration of PDAs is as bad.

2.3.2 CASIO Cassiopeia E-200G together with NOKIA 6310i

The CASIO Cassiopeia E-200G is a PDA running MS-Windows PocketPC 2002 and has a display of 240x320 pixels (width x height) that displays up to 65k colours. It is powered by a 206MHz processor and has a built-in memory of 64MB which can be extended using SD, MMC and even CF cards. Actually, we use an IBM 1GB MicroDrive (CF II card) to store data. Since we updated the operating system once we never again experienced a system crash.

There is a real big problem with the duration of the accumulator power. We tried to exchange the MicroDrive with a digital camera, i.e. the CANON PowerShot G3, but even with a fully loaded accumulator we could only have a closer look on 20 pictures before the system was automatically shut down to avoid data loss due to a too low accumulator voltage. Without using devices consuming so much power the PDA can be operated for approx. 4 hours. This is very short and prevents the Cassiopeia from being used on long travels but confirmed by all tests we read. But we found the extraordinary connectivity features to be more important for our usage profile.

The Cassiopeia is synchronised with a PC running any of MS-Windows versions using a so-called cradle and MS-ActiveSync V3.5. It can be configured to synchronise via the IrDA port as well. The PocketInternetExplorer can even view WML pages but is not capable of handling WML scripts. We tried out the KLONDIKE WAP browser version 1.5 and experienced a failure, too, but with the new version 1.7 even this feature can be used. This is nice and can help to save much money in real life because the WAP services on the internet are usually designed with the aim of minimising the amount of data to be transferred.

Before the NOKIA 6310i could be used in GPRS mode, we had to figure out that the famous 'AT' in the so-called 'AT command' that is entered on the PDA and tells the 6310i how to connect to the internet gateway of the mobile services provider has to be left out under MS-Windows PocketPC 2002, though these two characters appear in all the manuals we found. But again the web turned out to be a very good source of information here.

With MS-Windows PocketPC light versions of the famous MS-Office software are shipped, but the 'light' has to be taken seriously. For example, if a MS-Word 97 document is modified on a PocketPC 2002 device, all of the line and character formatting is lost when importing it back into the PC version! But writing some short notes is quite convenient and the MS-Reader software to display eBooks is really nice.

2.3.3 PSION 5mxPRO together with NOKIA 6310i

The PSION 5mxPRO is a PDA of palmtop size which is equipped with the same operating systems as the R380s, i.e. EPOC. But the basic difference is that on the PSION additional software may be installed. It turned out to be a necessary feature in this project, because the operating system assigns the same IP number to the PSION and the radio modem when connecting to the internet. This prevents a GPRS connection from being successfully established. Please observe student 'Schmiddi' just after being caught by this trap. Searching the web (obviously using another device for internet access) yielded the explanation of the connection failure as well as a solution to this problem (see www.psiongerm.de/html/gprs.html). Thus, after an update of the EPOC operating system and installation of some additional software, configuring the PSION for internet access using the NOKIA 6310i in GPRS mode was done exactly as described in the internet and done after 5 minutes. The browser OPERA 3.62 shipped with the PSION was used to display HTML-formatted content. A built-in WAP browser could have been used to display WML pages, but as for the PDAs the main subject was to test internet access, we only made a short test with one WML(S) page which was successful.And this PSION can only be operated with batteries, not with accumulator cells.

2.3.4 PALM m515 together with NOKIA 6310i

The PALM m515 is delivered without any software for displaying content from the internet. Student 'Nibbi' had chosen the combined HTML/WML browser called BLAZER. Configuring the internet access according to a description provided on the web (see www.letyourhandyglow.de/m505/) was easy and done within 5 minutes. So student 'Nibbi' looks quite comfortable at the beginning of his hands-on session.

2.4 Summary

Generally speaking, mobile devices provide access to three different kinds of media: browsable content, messages, and phone calls.

The first generation of smartphones like the R380s is restricted in the kind of browsable content: they can handle only WML pages. It turned out to be very tedious work to create scientific content in this mark-up language and the variety in display size and aspect ratio of common smartphones is large and not known to the document server even using tricks like evaluating the HTTP headers. Some content providers on the web offer on-the-fly conversion of HTML content, but the problems described in the preceding sections show that it is unlikely that scientific content can be successfully converted in this manner.

The communication capabilities of smartphones are usually quite good. And of course there are some applications of smartphones which could help students to organise their studies more efficiently, using mobile library services (prolongation of lending periods, database look-ups etc.), e.g. The author very much appreciates this kind of service offered by the library of the nearby Ruhr-Universität Bochum (see http://www.ub.ruhr-uni-bochum.de/informationen/benplatzwww.html, in German).

But we think the main advantage of smartphones as compared to usual mobile phones is a convenient display of long messages, .i.e. chained SMS or even short text emails. On common mobile phones only a few words can be displayed and read simultaneously.

Concluding, we think it doesn't make any sense at all to create WML-formatted scientific content, and even the argument of a small amount of data of these pages which make them fast and cheap to download isn't caused by the WML format itself but can be realised in HTML as well, as our course and all the service pages demonstrate.

The situation is better for PDAs, they can display content formatted in HTML and even eBooks. But the display size of common PDAs is still very small as compared to that of PC monitors, so some adoption work has to be done as simple down-scaling often leads to vanishing of the fine structures in graphics. Using built-in or additional software and a mobile phone as radio modem it is possible to access nearly all pages of the internet, even those containing plug-ins or JAVA content. But if a content provider wants to assure a convenient display on PDAs, the pages should be tested on current PDA models and re-designed if necessary. The display size of nearly all PDAs is 240x320 pixels (width x height) and the newer ones allow to display at least 4096 colours. Some PDAs are even shipped with a standard word processor or spreadsheet application, but these are restricted to basic functions.

Concluding, we recommend that HTML pages used for mobile access are to be designed for a screen size of 240x320 pixels (width x height) and without any unnecessary graphic paraphernalia. Whether JAVA, SWING or plug-in stuff like FLASH and SHOCKWAVE or other multi-media features are properly supported by the current PDAs will be subject of future research.

We don't think that combining a PDA and a mobile phone into one single device emphasises the strong points of both specialised tools. For example, if a flight marshal discovers a thing resembling an antenna you will have a very boring travel because nobody taught these people how to loose a discussion. Very often you are not allowed to use mobile phones in public transport because they might at least disturb the on-board electronics.

The basic difference between messages and phone calls is in terms of synchronised activity of the persons involved: whereas messages allow for asynchronous work, phone calls require the activities of at least two persons to be synchronous. This means phone calls will be the exception and messages will be the rule in student support services. The question to be answered in the future is whether students are willing to pay for SMS services or prefer emails, only the latter being able to deliver attachments.

Generally speaking, the configuration of mobile devices is much too complicated for the average user. Administrating access to WML content on the web using the ERICSSON R380s, the WAP APN entries of the NOKIA 6310i, and the tricks of entering the correct AT string for use of GPRS in the PDA connection menus seem to be designed by engineers and for engineers only.

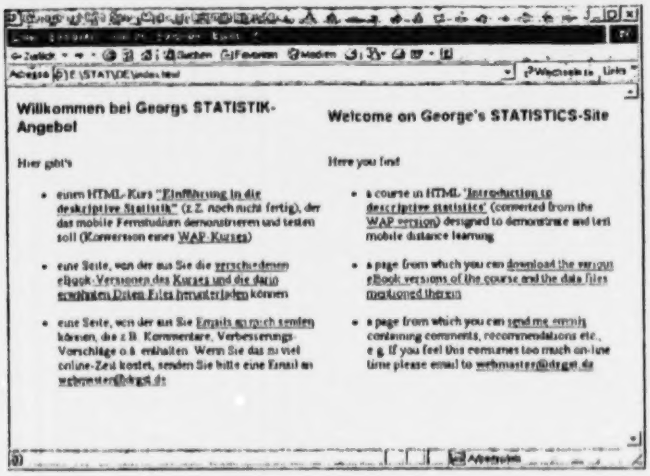
The next chapter describes the experiences of the author and the students when using the mobile devices introduced in this chapter for mobile learning.

3 Mobile learning in practice

Though we tried hard we found no real students of the FeU or pupils owning a R380s or a PDA. Thus, we decided to plan hands-on sessions providing our R380s to registered students of the course. For comparison with the HTML and eBook versions, hands-on sessions with our CASIO Cassiopeia E-200G were planned, and fortunately it turned out that two registered students owned a PDA, i.e. a PSION 5mxPRO and a PALM m515, resp., which were used too. We decided to consider three different groups of people as relevant for our hands-on sessions: the first group is formed by pupils of age 16 and older, they were considered because they usually type SMS faster on a mobile phone using only one thumb than a secretary types on a PC keyboard using ten fingers and generally seem to be fond of 'cool' gadgets; the Hale-Paghen-Schule in Buxtehude, Germany, is gratefully acknowledged for organising the hands-on sessions with the pupils. The second group is formed by students of social sciences in the first year, they were considered because they have to learn the content of the courseware anyway and thus can compare usual lesson learning to mobile learning using the offered devices. The third group is formed by business people using a mobile phone and/or PDA for organising their everyday work, but not for the purpose of learning.

This chapter focuses on the technical details of mobile learning in practice. A detailed analysis of the results of the questionnaires filled in by all attendees may be found in the second part of this report. For downloading the courseware onto the PDAs, a NOKIA 6310i was used. As our mobile services provider T-D1 only offers GPRS as enhanced transfer technique, we had no chance to test HSCSD. During the pre-test of the course, it turned out that using the NOKIA phone as radio modem for the E-200G was easy but that the connection speed was limited to less than 9.1kBit/s, i.e. only a single channel was used. We asked T-D1 for a solution and after listening to the latest hits on the hotline for about one hour altogether, we were advised to visit the local service centre. There the network technicians checked the local area mobile network for failure and concluded the 'outdated' software of the NOKIA (3 month old!) to be the reason. Thus, a travel to the nearby city of Dortmund turned out to be necessary to visit the nearest NOKIA service partner. The people there needed less than 2 hours to update the version of the built-in software from 4.1 to 4.7. After that, we observed that at least three channels are used for downloads.

The following figure shows the home page of the course on a 14" PC monitor, a PDA and the R380s. For the purpose of graphical clarity, screenshots are preferred to pictures of the real devices, but they are properly scaled. The screenshots for the PDA and PC show the HTML version of the course.



Willkommen bei Georgs STATISTIK-Angebot

Hier gibt's

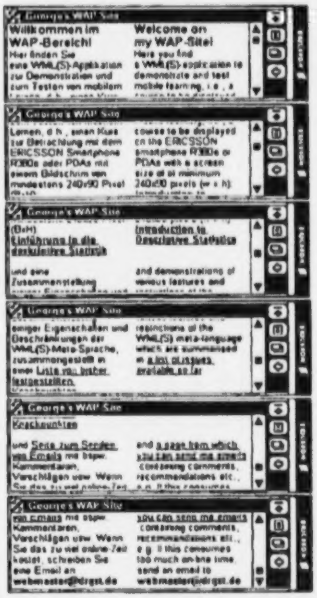
- einen HTML-Kurs "Einführung in die deskriptive Statistik" (z.Z. noch nicht fertig), der das mobile Fernstudium demonstrieren und testen soll (Konversion eines WAP-Kurses)
- eine Seite, von der aus Sie die verschiedenen eBook-Versionen des Kurses und die darin erwähnten Daten-Files herunterladen können
- eine Seite, von der aus Sie Emails an mich senden können, die z.B. Kommentare, Verbesserungs-Vorschläge o.ä. enthalten. Wenn Sie das zu viel online-Zeit kostet, senden Sie bitte eine Email an webmaster@drgst.de

Welcome on George's STATISTICS-Site

Here you find

- a course in HTML 'Introduction to descriptive statistics' (converted from the WAP version) designed to demonstrate and test mobile distance learning
- a page from which you can download the various eBook versions of the course and the data files mentioned therein
- a page from which you can send me emails containing comments, recommendations etc., e.g. if you feel this consumes too much on-line time please email to webmaster@drgst.de

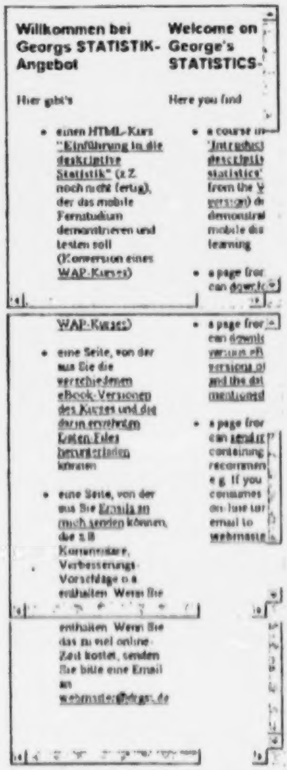
Figure 3-1a: STAT course in HTML on 14" PC monitor



Willkommen im WAP-Bereich! Hier finden Sie eine WML(S)-Applikation zur Demonstration und zum Testen von mobilem Lernen, d.h., einen Kurs zur Betrachtung mit dem ERICSSON Smartphone R380s oder PDAs mit einem Bildschirm von mindestens 240x90 Pixel (BxH) Einführung in die deskriptive Statistik und eine Zusammenstellung einiger Eigenschaften und Beschränkungen der WML(S)-Meta-Sprache, zusammengestellt in einer Liste von bisher festgestellten [illegible] und Seite zum Senden von Emails an mich bzw. Kommentaren, Vorschlägen usw. Wenn Sie das zu viel online-Zeit kostet, schreiben Sie eine Email an webmaster@drgst.de

Welcome on my WAP-Site! Here you find a WML(S)-application to demonstrate and test mobile learning, i.e., a course to be displayed on the ERICSSON smartphone R380s or PDAs with a screen size of at minimum 240x80 pixels (w x h): Introduction to Descriptive Statistics and demonstrations of various features and restrictions of the WML(S) meta-language which are summarised in a list of issues available so far and a page from which you can send me emails containing comments, recommendations etc., e.g. if this consumes too much on-line time, send an email to webmaster@drgst.de

Figure 3-1c: STAT course in WML on R380s (emulator)



Willkommen bei Georgs STATISTIK-Angebot

Hier gibt's

- einen HTML-Kurs "Einführung in die deskriptive Statistik" (z.Z. noch nicht fertig), der das mobile Fernstudium demonstrieren und testen soll (Konversion eines WAP-Kurses)
- eine Seite, von der aus Sie die verschiedenen eBook-Versionen des Kurses und die darin erwähnten Daten-Files herunterladen können
- eine Seite, von der aus Sie Emails an mich senden können, die z.B. Kommentare, Verbesserungs-Vorschläge o.ä. enthalten. Wenn Sie das zu viel online-Zeit kostet, senden Sie bitte eine Email an webmaster@drgst.de

Welcome on George's STATISTICS-

Here you find

- a course in 'Introduct descripti statistics' from the W version) d demonstrat mobile dis learning
- a page fror can downlc various eB versions of and the dat mentioned
- a page fror can send m containing recommen e.g. If you consumes on-line tir email to webmaste

Figure 3-1b: same as a) but on typical PDA screen

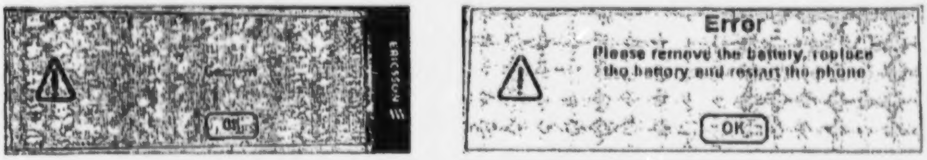
The relatively long email address in the last line prevents both columns from being displayed smaller.

From fig. 3-1, the most outstanding problem of the mobile devices becomes evident: the relatively small screen size which leads to extensive scrolling if a page isn't extremely short or extensive use of links, if the pages are kept small enough to fit on the screen. And sometimes even horizontal scrolling can't be avoided, though this is rated as annoying by all students.

During the hands-on sessions, usually no PC was available, therefore we had to test the synchronisation between the R380s or the PDAs and a PC in our office and by ourselves. We also performed regular tests of the download speed using GPRS.

3.1.1 Smartphone R380s

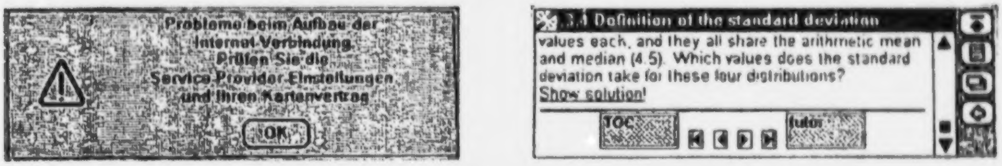
The most annoying incidents during the hands-on sessions with the R380s were the frequent error messages and the frequent interruptions of the CSD connections prescribed by the system to save money. The following figure shows the 'hall of anger'.



Error

Please remove the battery, replace the battery and restart the phone

(a) (translation: *closed/blocked*) (b)



Probleme beim Aufbau der Internet-Verbindung. Prüfen Sie die Service-Provider-Einstellungen und Ihren Kartenvertrag

3.4 Definition of the standard deviation

values each, and they all share the arithmetic mean and median (4.5). Which values does the standard deviation take for these four distributions?

Show solution!

(c) (translation: *problems when establishing an internet connection. Verify the settings for the service provider and your SIM contract.*) (d)

Figure 3-2: Some WAP error messages or failures encountered during mobile learning

Generally speaking, either the phone worked well during the WAP sessions, or it never started to work properly. We finally discovered that our mobile services provider T-D1 offers two different WAP gateways, one is dedicated to be used for checking email at the personal T-Online account, the other is for usual WAP traffic and belongs to T-Mobile. If the settings are chosen to use the T-Mobile WAP gateway, as they were for the final project conference in Dublin, the phone seems to work well and the connection is (re-)established within 12 seconds. If the WAP gateway of T-Online is used, there are frequent connection errors sometimes resulting in meaningless error messages, as can be seen in fig. 3-2 (a) and (c). The text causes the user to feel uncertain whether having paid the bill or not. Fig. 3-2 (b) shows that not only MS-Windows systems may crash and need a reboot, and fig. 3-2 (d) shows what happens if a page isn't completely loaded.

But when the R380s worked properly, all students seemed to work quite concentrated and were able to correctly solve the exercises. The following figure shows two right-handed students. In the hands-on sessions the two left-handed students told us, that the size of the R380s was just as small enough to grip around the body and be able to use the scroll-bars without blocking their view by the hand or arm. But for an observer the R380s was hidden, so no picture is available here.

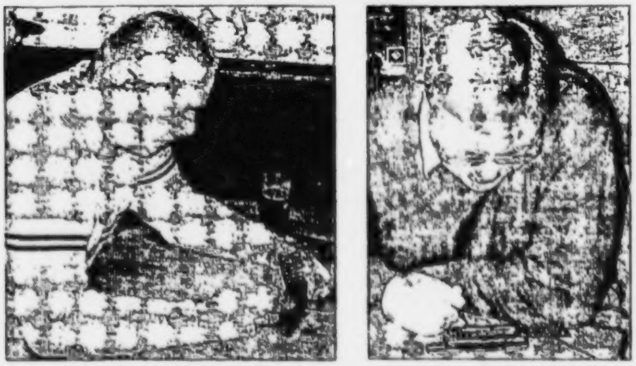


Figure 3-3: R380s in use for mobile learning
left: student 'Garten'; right: student 'Prismo'

This mode of operation even turned out to have an advantage in some unfavourable light conditions. As can be seen from the picture showing student 'Garten', the screen may show dazzling effects. But if the right hand is used to hold the body of the R380s, the antenna will likely be shaded and this leads to a high power output and a bad reception.

3.1.2 CASIO Cassiopeia E-200G

We tried the WML and HTML version of the course on this PDA, as can be seen below.

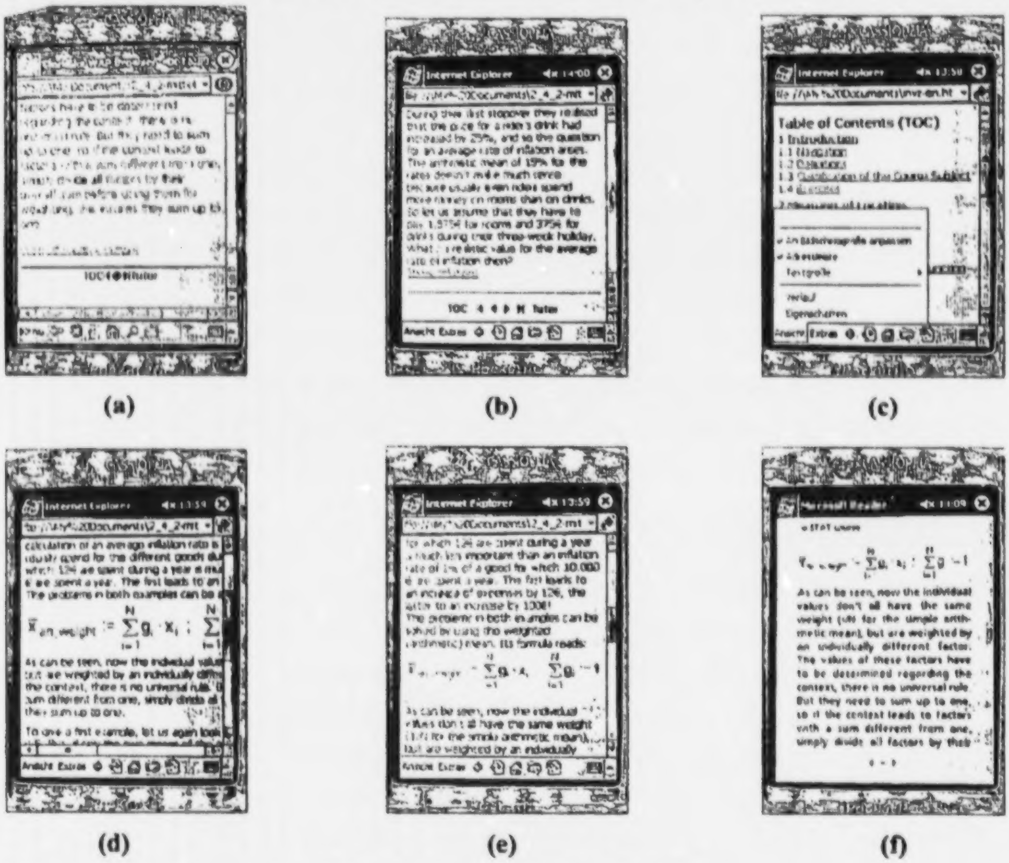


Figure 3-4: Courseware as displayed on the CASIO E-200G

(a) Klondike WAP browser **(b) PocketIE** **(c) PocketIE view menu**
(d) PocketIE as is **(e) PocketIE fit to screen** **(f) MS Reader eBook**

Basically, using the KLONDIKE WAP browser and the WML version works as well as using the PocketIE and the HTML version of the course. But only the HTML version allows for the download of a zipped file containing the whole courseware and thus enables off-line reading of the course. Obviously, eBooks and additional material can only be downloaded using at least an HTML home page for access to the course.

The screen size of the PDA is large enough to have a graphic and the text explaining its main points together on one single screen. But as can be seen from fig. 3-4a, the navigation bar looks quite cluttered in the KLONDIKE browser and even does not allow to visually separate the 'back' resp. 'forward' button. The PocketIE displays the HTML version more close to way the standard IE does than the KLONDIKE browser with respect to the R380s built-in WAP browser.

But even in the HTML and eBook version the relatively small screen size of the PDA causes some problems. If a graphic is larger than the screen size, this problem can basically be solved in two ways: either scrolling (see fig. 3-4d) or using the built-in feature 'fit to screen' (see fig. 3-4e). Whereas the latter is more convenient for undisturbed reading and prescribed in the eBook version (see fig. 3-4f), it may cause tiny structures of the graphic to vanish, as can be seen in fig. 3-4e,f.

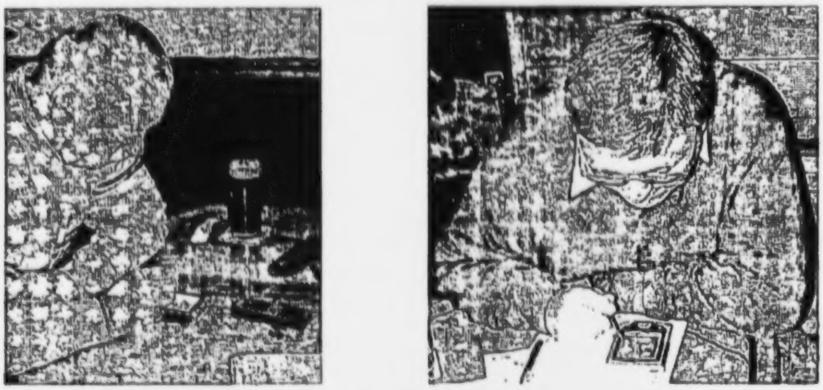


Figure 3-5: E-200G in use for mobile learning
left: student 'Garten'; right: student 'Prismo'

The left-handed students told us they were unable to use the vertical scroll-bar at the right border of the screen unless using their less trained right hand. This is due to the larger screen and the 'portrait' layout of the PDA screen as compared to the 'landscape' screen layout of the R380s. But it is obvious from fig. 3-4 that the operating system of a PDA should provide a means of adjusting on which side of the screen the vertical scroll-bars shall appear. Perhaps, the eBook version, which is designed without using any scroll-bars (see fig. 3-4f), may better fit their needs. But using eBooks means to have 'hard' page breaks within the text of a section, which force the reader to keep in mind some of the content of a previous page when reading the following one. This isn't necessary when using scroll-bars.

Another proposal of the students was to use a kind of scroll wheel for PDAs, as it is done in usual PC mice today. This would allow for a more convenient scrolling. But it seems that anyway PDAs of the size of the E-200G and larger don't make the user take it in their hands. Whereas some students (see 'Garten' in fig. 3-3, e.g.) held the R380s in one hand and the stylus in the other for optimal visibility, all students placed the PDA handed over to them on the table in front of them, even if the eBook version was used for off-line reading. And due to the extremely strong dazzling effect of the PDA screen, they sometimes had to move their heads in a very inconvenient position, as can be seen from the following figure.

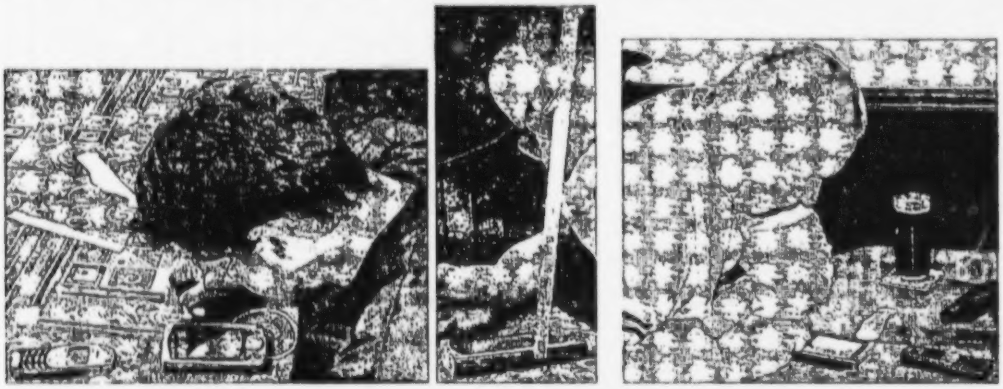


Figure 3-6: E-200G in use for mobile learning
left & middle: student 'Broken Trust'; right: student 'Garten'

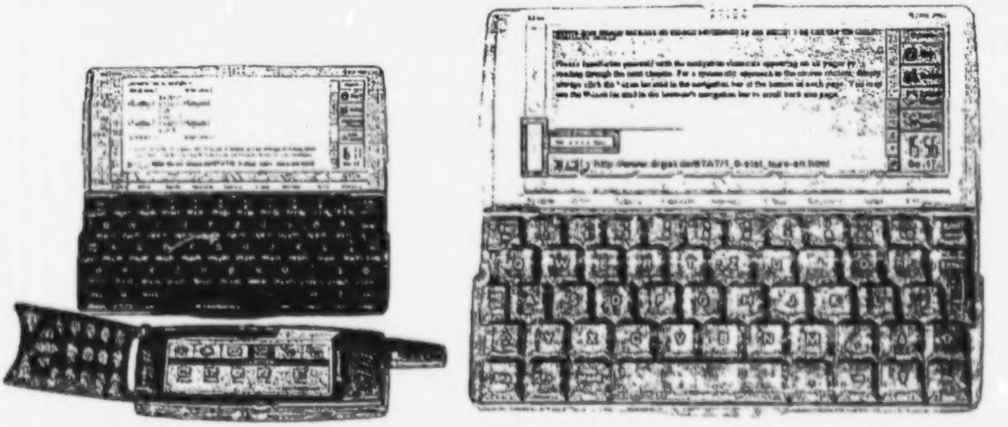
I probably wouldn't like to wake up in the morning after having read the courseware for 3 hours in the evening before and in a manner as depicted in figs. 3-5 and 3-6.

3.1.3 PSION 5mxPRO

The screen area of the PSION is about 4 times larger than that of the R380s, as can be seen in fig. 3-7a, but is of the same kind, i.e. only 2 colours that are a mud green background and a mud grey foreground. It has to be operated using 2 batteries of 1.5V, as the device is automatically shut down at a power supply voltage of 2.4V, which means that only recently and fully charged accumulator cells can be used and even only for approx. half an hour.

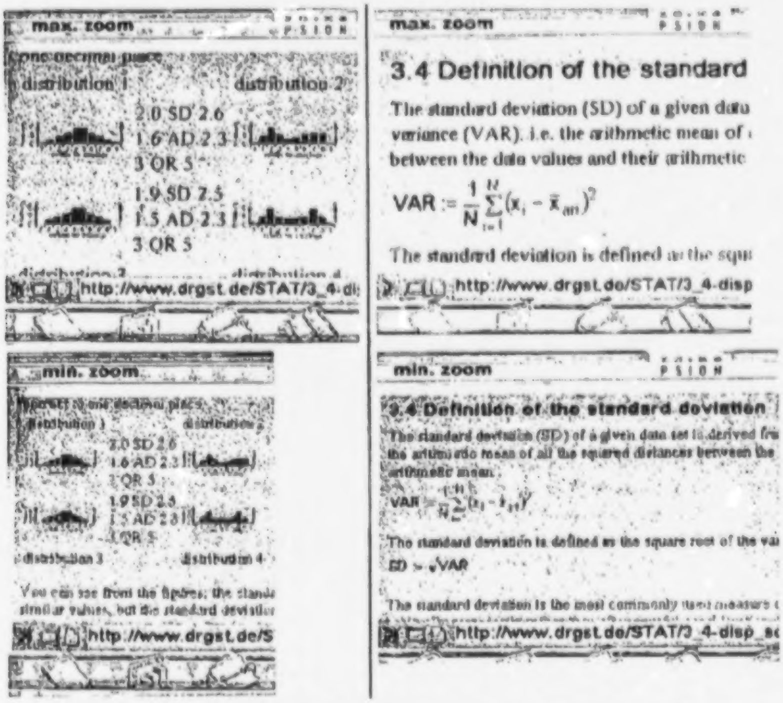
After scrolling down to the bottom of the first page displayed, we were totally disappointed about the stamp-like size of the symbols in the navigation bar, as can be seen from fig. 3-6(b). To our amazement and in contrast to the behaviour of common PC browsers but analogous to the 'fit to screen' functionality of the PocketIE, the zoom functionality provided by the PSION affects pictures, too. This is demonstrated in figure 3-8.

Only at the largest zoom level, the information contained in all the figures and the navigation bar could be perceived easily. But unfortunately, there is no feedback under which zoom level the screen is actually operated.



(a) (b)

Figure 3-7: (a) Comparison of PSION 5mxPRO and R380s
(b) PSION 5mxPRO in detail



max. zoom
PSION
one decimal place
distribution 1
distribution 2
2.0 SD 2.6
1.6 AD 2.3
3 QR 5
1.9 SD 2.5
1.5 AD 2.3
3 QR 5
http://www.drgst.de/STAT/3_4-di
max. zoom
PSION
http://www.drgst.de/STAT/3_4-disp
min. zoom
distribution 1
distribution 2
2.0 SD 2.6
1.6 AD 2.3
3 QR 5
1.9 SD 2.5
1.5 AD 2.3
3 QR 5
distribution 3
distribution 4
http://www.drgst.de/S
min. zoom
PSION
http://www.drgst.de/STAT/3_4-disp_s

3.4 Definition of the standard

The standard deviation (SD) of a given data
variance (VAR), i.e. the arithmetic mean of
between the data values and their arithmetic

$$VAR := \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x}_{an})^2$$

The standard deviation is defined as the squ

You can see from the figures; the stand
similar values, but the standard deviatio

3.4 Definition of the standard deviation

The standard deviation (SD) of a given data set is derived fro
the arithmetic mean of all the squared distances between the
arithmetic mean.

$VAR := \frac{1}{N}\sum(x_i - \bar{x}_{an})^2$

The standard deviation is defined as the square root of the va

$SD := \sqrt{VAR}$

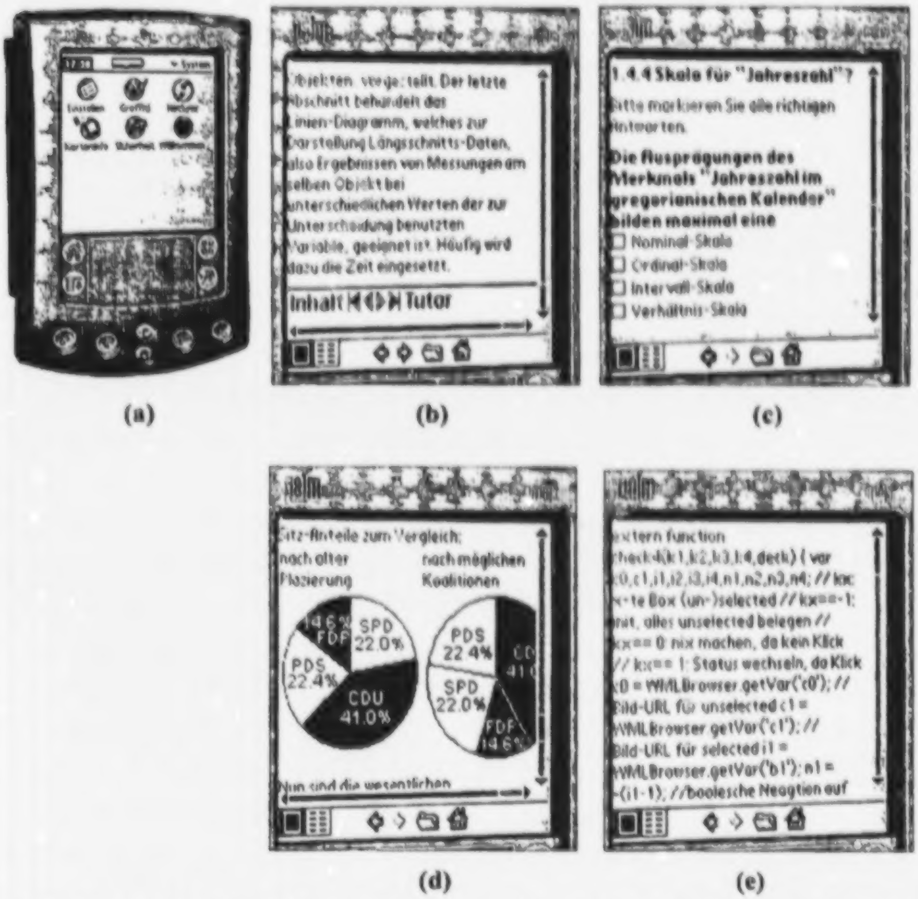
The standard deviation is the most commonly used measure o

Figure 3-8: Effect of zooming the display on the PSION 5mx PRO

To display the courseware formatted in HTML, the web browser OPERA was used. This software can display WML pages, too, but it is unable to handle WMLS. So we decided to use the HTML version only.

3.1.4 PALM m515

The PALM m515 (see fig. 3-9a) is a PDA resembling the E-200G. The additional browser software BLAZER was downloaded and installed by student 'Nibbi' as the PALM comes without any built-in browsers. As BLAZER is advertised to display HTML and WML pages as well, we tried out both versions of the course. Unfortunately, the eBook versions couldn't be tested as student 'Nibbi' did not want to install some additional shareware.


(a) (b) (c)

bjekten vorgeteilt. Der letzte
bschnitt behandelt das
inien-Diagramm, welches zur
arstellung Längsschnitts-Daten,
also Ergebnissen von Messungen am
selben Objekt bei
unterschiedlichen Werten der zur
Unterscheidung benutzten
Variable, geeignet ist. Häufig wird
dazu die Zeit eingesetzt.

Inhalt |◀ ◀▶ ▶| Tutor

1.4.4 Skala für "Jahreszahl"?

itte markieren Sie alle richtigen
ntworten.

**ie Ausprägungen des
Merkmals "Jahreszahl im
gregorianischen Kalender"
bilden maximal eine**

☐ Nominal-Skala
☐ Ordinal-Skala
☐ Intervall-Skala
☐ Verhältnis-Skala

itz-Anteile zum Vergleich:
nach alter Plazierung
nach möglichen Koalitionen

un sind die wesentlichen

```
xtern function
heck4(k1,k2,k3,k4,deck) { var
c0,c1,i1,i2,i3,i4,n1,n2,n3,n4; // kx:
x-te Box (un-)selected // kx==-1:
rst, alles unselected belegen //
kx== 0: nix machen, da kein Klick
// kx== 1: Status wechseln, da Klick
c0 = WMLBrowser.getVar('c0'); //
Bild-URL für unselected c1 =
WMLBrowser.getVar('c1'); //
Bild-URL für selected i1 =
WMLBrowser.getVar('b1'); n1 =
-(i1-1); //boolesche Neagtion auf
```

(d) (e)

Figure 3-9: a) Palm m515 (b), (d) HTML page with browser BLAZER
(c), (e) WML page and effect of embedded WMLS

Browsing usual HTML and WML pages was done without any problem, but an embedded WML script made the BLAZER software display its source code, which seems a bit surprising. The scroll-bars are very small which seems to be a disadvantage if the PDA is used on the move.

BEST COPY AVAILABLE

3.2 Summary

Generally speaking, the students appreciated the hands-on sessions practising mobile learning using the smartphone ERICSSON R380s and the PDA CASIO E-200G or comparable devices. But for the purpose of working through complex material the students would only use a PDA and not a smartphone (for details see part II of this report). On top of that, modern smartphones support access to content formatted in HTML. Thus, there is evidence that it makes no sense to develop and present scientific content in the WML format. And much additional research is necessary to analyse under which circumstances HTML or comparable formats are to be used and when eBooks are to be preferred instead. Using documents in HTML format seems to yield more reliable and predictable output formats than in the WML format.

Preparing the first generation of mobile devices for access to the internet is still too complicated for the average user. If mobile devices shall be a reliable tool, there has to be an easily understandable interface for synchronising contacts and documents between a mobile device and several desktop computers or other mobile devices. The configuration of a mobile phone to be used as radio modem, whether used as a second device together with a PDA or included in a smartphone, has to become as easy as starting a car.

The usability of mobile devices has to be improved significantly before they will be widely accepted for mobile learning. This concerns the screen configuration, i.e. switching between landscape and portrait mode as well as the configuration of the position of scroll bars, as well as the invention of additional elements like personal colour schemes or scroll wheels.

The students recommend a much faster download speed than today for mobile access to any content. Though GPRS can solve the re-/dis-connect problem existing for usual CSD connections, the data transmission rate is still much slower than that of a single ISDN line, i.e. approx. 27kBit/s as compared to 64kBit/s.

It seems remarkable that those students of the course, who work for their money and are not "pampered" by the state or their parents generally rate mobile learning much worse than all other students. This leads to the last chapter of this report which is concerned with the costs of mobile learning.

4 Cost of mobile learning

We now try to estimate the cost of mobile learning. On the one hand, there are the expenses for the mobile devices. A current full featured PDA model costs about 600€ incl. the software necessary for mobile data transfer and content visualisation. A mobile phone that comes with proper firmware for data transfer costs about 500€ during a time span of 2 years, either the whole sum at once when buying it without a provider contract or about 200€ when buying it and about 15€ a month during the next 2 years for the provider contract.

The data transmission is charged separately and all mobile services providers in Germany offer a variety of different tariffs, thus it is nearly impossible to give an overview. Therefore, we just show what we would be charged by our mobile services provider T-D1 for two different user profiles: a 'power user' who is always on the move and uses the mobile services every day a week , and a 'home user' who uses the mobile services only one day a week. But it should be kept in mind that if a specific enhanced data transmission technique is to be used, the provider should be chosen accordingly, for example, T-D1 does not offer HSCSD.

T-D1 tariff name (in German !!)	**Basic***	**Profi**	**Office**
Monthly basic cost in €	0,00	9,95	39,95
Daily basic cost in €	0,09	0,00	0,00
Free amount of traffic in 100 kByte	0,00	10,00	200,00
Cost of 100kByte WAP traffic in €	2,90	0,90	0,19
Cost of 100kByte WWW traffic in €	2,90	0,29	0,19

Table 3: T-D1 GPRS tariffs; *: this tariff is automatically assigned to a new contract

Monthly cost for *frequent* mobile learning	**Basic***	**Profi**	**Office**
Basic cost	0,00	9,95	39,95
30 times daily basic cost	2,70	0,00	0,00
Checking email 3 times a day using WAP, 33 kByte each, daily 100 kByte => monthly 3 MByte	87,00	27,00	5,70
Access to 10 WAP pages daily, 4 kByte each, 40 kByte daily => 1.2 MByte monthly, e.g. for library services	34,80	10,80	2,28
Access to the WWW, e.g. downloads, emails with attachments, other materials, 200 kByte daily => 6 MByte monthly	174,00	17,40	11,40
WAP: reduction due to free amount of traffic, weighted according to traffic proportion: 4,2 of 10,2 MByte	0,00	-3,69	-7,98
WWW: reduction due to free amount of traffic, weighted according to traffic proportion: 6 of 10,2 MByte	0,00	-1,71	-11,40
Overall monthly cost in €	**298,50**	**59,75**	**39,95**

Table 4: Monthly cost of mobile learning for an average 'power user'

Monthly cost for *in-frequent* mobile learning	**Basic***	**Profi**	**Office**
Basic cost	0,00	9,95	39,95
4,3 times daily basic cost	0,39	0,00	0,00
Checking email 3 times on one day a week using WAP, 33 kByte each, daily 100 kByte => monthly 430 kByte	12,47	3,87	0,82
Access to 10 WAP pages on one day a week, 4 kByte each, 40 kByte daily => 172 kByte monthly, e.g. for library services	4,99	1,55	0,33
Access to the WWW, e.g. downloads, emails with attachments, other materials, 200 kByte a week => 860 kByte monthly	24,94	2,49	1,63
WAP: reduction due to free amount of traffic, weighted according to traffic proportion: 602 of 1462 kByte	0,00	-3,69	-1,14
WWW: reduction due to free amount of traffic, weighted according to traffic proportion: 860 of 1462 kByte	0,00	-1,71	-1,63
Overall monthly cost in €	**42,79**	**12,46**	**39,95**

Table 5: Monthly cost of mobile learning for an average 'home user'

Please note that in the preceding tables a decimal comma is used! The data presented in tab. 3 are provided by T-D1 on the web (http://www.t-mobile.de/wap/1,1821,3621-_,00.html). The labels 'Basic', 'Profi' and 'Office' refer to the three official German tariff names of T-D1.

Though the assumptions made for the traffic details in the calculations above may be questioned, the results nevertheless indicate that mobile access to WAP or WWW is extremely expensive as compared to the access using a standard ISDN or DSL contract. It is common practice to offer a flat-rate contract at a cost of about 40€ and a maximum transfer volume of about 4GByte a month, which means a 'power user' does not get 20MByte but fifty thousand times this volume for free at the same expenses. And the PDA-like devices are extremely expensive and come with a largely reduced functionality as compared to a standard desktop PC.

5 Resume

This report describes the experience gained in the LEONARDO project 'from e-learning to m-learning' from a more technical point of view.

During the first phase of the project, a short course on descriptive statistics was developed and basic student support services were designed. Then the course and the services were implemented on a web server for access by mobile devices like the smartphone ERICSSON R380s and via the WAP technique. Finally, this version of the course was tried out with several people.

The main findings of this first project phase are:

- The tools for creating WML content that are provided by the 'big players' of the mobile business are by far less effective than common HTML generators.
- The level of predictability of the layout of WML content on different mobile devices is even lower than that for HTML content in different common web browsers.
- The mark-up language WML up to version 1.3 only supports black and white pictures and in a format unknown to HTML.
- The screen size of smartphones resembling the R380s is too small for presenting complex material which requires a graphic and at least some sentences to be visible simultaneously.
- But the screen is large enough to read and write long SMS messages or even text emails.
- The configuration of smartphones like the R380s for accessing content on a web server is much too complicated for the average student.

The findings of the first project phase led to the conclusion that smartphones resembling the ERICSSON R380s are not suitable for mobile learning but can only serve as efficient tools for communication.

In a second project phase the courseware and the pages related to student services were transformed into other document formats. For use on different PDAs, i.e. the main class of current mobile devices, a version in HTML as well as two eBook formats were compiled and tried out on three different PDAs.

The main findings of the second project phase are:

- For the HTML versions the very mature tools commonly used for the creation of web content can be used, but the screen size of common PDAs, i.e. approx. 240x320 (width x height) has to be kept in mind.
- If graphics are automatically scaled down to fit to the screen it often happens that tiny structures simply vanish. It thus seems unlikely that the on-the-fly converters available on the web can do a satisfactory job when processing scientific content.
- The browsers available for PDAs that can handle WML as well as HTML content usually fail when they encounter a WML script but properly process HTML JavaScript.
- The screen size of PDAs is large enough to present complex material and common browsers can display at least 4096 colours. The operation of the vertical scroll bar may be complicated for left-handed persons.

- The eBook formats allow for storing personal remarks, i.e. bookmarks, notes, and even sketches, with the document. But they are suitable only for those texts that can be read more ore less like novels and do not require extensive use of links.
- The configuration of PDAs for use with mobile phones acting as radio modems is still a bit too complicated.

On top of that, the prices of the mobile devices and the tariffs for mobile access to WAP or the WWW are not supporting a broad acceptance of mobile learning at the moment. But it will be interesting to see what happens when small tablet PC devices provide nearly all the features and media known from desktop PCs and the factor between the prices for mobile respective home access of content on the web has decreased from its actual value of fiftythousand to about fifty.

6 Appendices

6.1 Addresses of courseware on the web and sample pages

Due to the fact that the web server of the FeU wasn't prepared for WAP during the project phase, the courseware IS PROVIDED on the private web site of the author of this report.

The German and English HTML version as well as links where to download the eBook versions and additional material can be found starting at the bilingual homepage of the HTML course: http://www.drgst.de/STAT/ . To view the original German and English WML versions of the course using a WAP enabled device or a proper browser, please start at http://wap.drgst.de/ .

Some of the work that was done in this project can be found starting at the ZIFF's project web page: http://www.fernuni-hagen.de/ZIFF/mlearn.htm . If you are interested in how technologies like JAVA applets can be used for interactive statistics on the web, please visit the link: http://www.fernuni-hagen.de/ZIFF/befrag/STATS/histo.htm (there may be problems with Java version 1.3 and above).

The following pages show some samples of the courseware, for the sake of simplicity formatted mainly in HTML and viewed on a PC monitor. For comparison, some pages are depicted in the original WML design for the R380s and as they would appear on a PDA when using the HTML version.

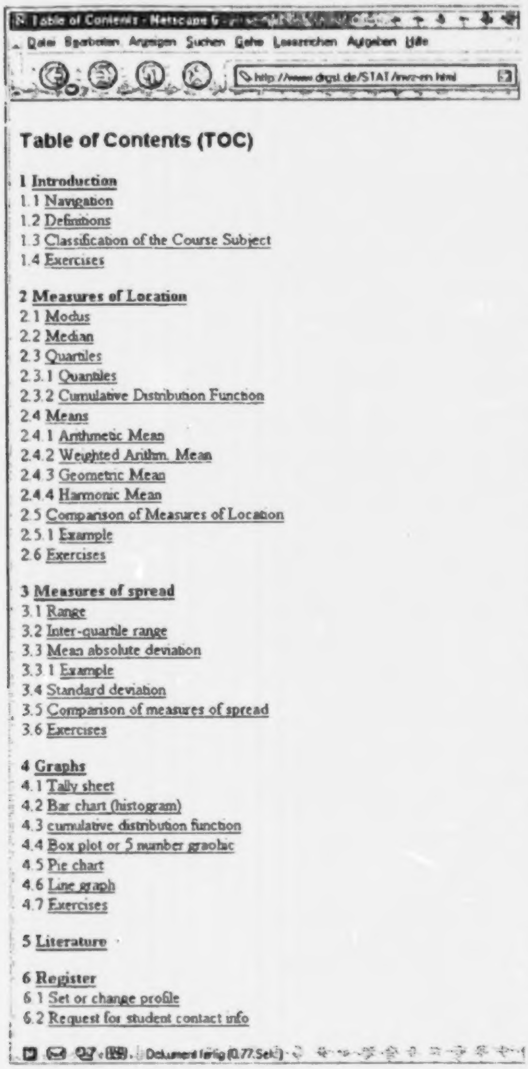


Table of Contents - Netscape 6
Datei Bearbeiten Ansehen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.drgst.de/STAT/invz-en.html
Dokument fertig (0.77 Sek.)

Table of Contents (TOC)

1 Introduction
1.1 Navigation
1.2 Definitions
1.3 Classification of the Course Subject
1.4 Exercises

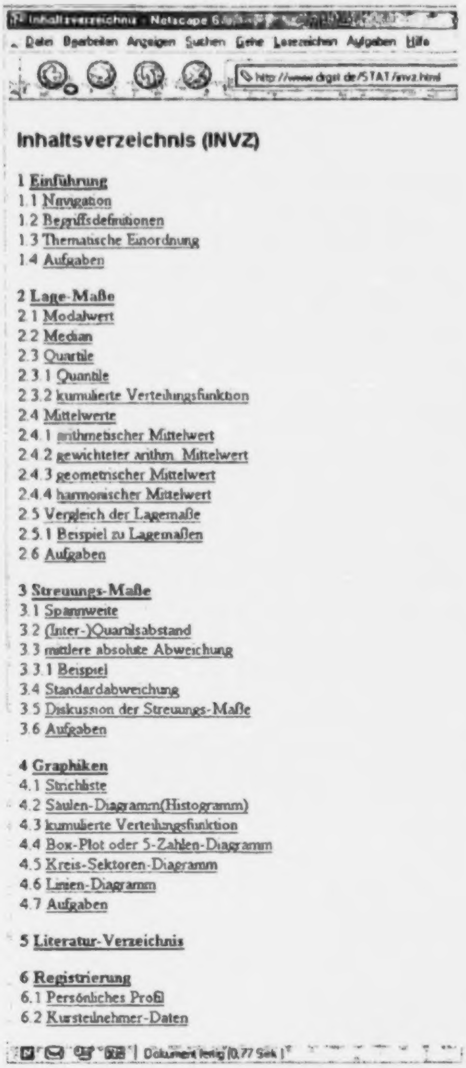
2 Measures of Location
2.1 Modus
2.2 Median
2.3 Quartiles
2.3.1 Quantiles
2.3.2 Cumulative Distribution Function
2.4 Means
2.4.1 Arithmetic Mean
2.4.2 Weighted Arithm. Mean
2.4.3 Geometric Mean
2.4.4 Harmonic Mean
2.5 Comparison of Measures of Location
2.5.1 Example
2.6 Exercises

3 Measures of spread
3.1 Range
3.2 Inter-quartile range
3.3 Mean absolute deviation
3.3.1 Example
3.4 Standard deviation
3.5 Comparison of measures of spread
3.6 Exercises

4 Graphs
4.1 Tally sheet
4.2 Bar chart (histogram)
4.3 cumulative distribution function
4.4 Box plot or 5 number graphic
4.5 Pie chart
4.6 Line graph
4.7 Exercises

5 Literature

6 Register
6.1 Set or change profile
6.2 Request for student contact info


Inhaltsverzeichnis - Netscape 6
Datei Bearbeiten Ansehen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.drgst.de/STAT/invz.html
Dokument fertig (0.77 Sek.)

Inhaltsverzeichnis (INVZ)

1 Einführung
1.1 Navigation
1.2 Begriffsdefinitionen
1.3 Thematische Einordnung
1.4 Aufgaben

2 Lage-Maße
2.1 Modalwert
2.2 Median
2.3 Quartile
2.3.1 Quantile
2.3.2 kumulierte Verteilungsfunktion
2.4 Mittelwerte
2.4.1 arithmetischer Mittelwert
2.4.2 gewichteter arithm. Mittelwert
2.4.3 geometrischer Mittelwert
2.4.4 harmonischer Mittelwert
2.5 Vergleich der Lagemaße
2.5.1 Beispiel zu Lagemaßen
2.6 Aufgaben

3 Streuungs-Maße
3.1 Spannweite
3.2 (Inter-)Quartilsabstand
3.3 mittlere absolute Abweichung
3.3.1 Beispiel
3.4 Standardabweichung
3.5 Diskussion der Streuungs-Maße
3.6 Aufgaben

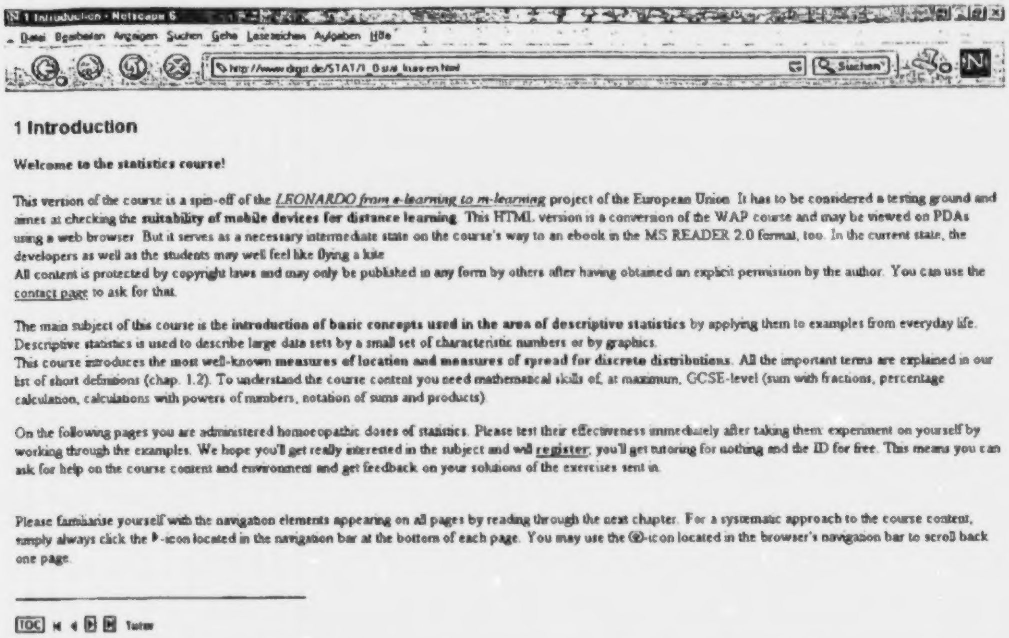
4 Graphiken
4.1 Strichliste
4.2 Säulen-Diagramm(Histogramm)
4.3 kumulierte Verteilungsfunktion
4.4 Box-Plot oder 5-Zahlen-Diagramm
4.5 Kreis-Sektoren-Diagramm
4.6 Linien-Diagramm
4.7 Aufgaben

5 Literatur-Verzeichnis

6 Registrierung
6.1 Persönliches Profil
6.2 Kursteilnehmer-Daten

Table of content of the STAT course (HTML)

BEST COPY AVAILABLE


1 Introduction - Netscape 6
Datei Bearbeiten Anzeigen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.drgst.de/STAT/1_0stat_kurs-en.html
Suchen

1 Introduction

Welcome to the statistics course!

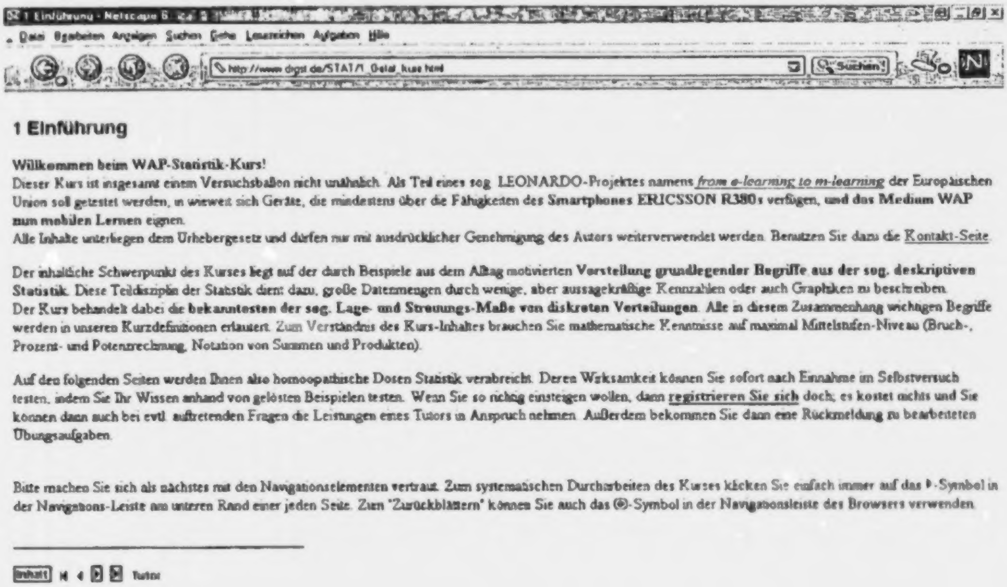
This version of the course is a spin-off of the *LEONARDO from e-learning to m-learning* project of the European Union. It has to be considered a testing ground and aimes at checking the **suitability of mobile devices for distance learning**. This HTML version is a conversion of the WAP course and may be viewed on PDAs using a web browser. But it serves as a necessary intermediate state on the course's way to an ebook in the MS READER 2.0 format, too. In the current state, the developers as well as the students may well feel like flying a kite.
All content is protected by copyright laws and may only be published in any form by others after having obtained an explicit permission by the author. You can use the contact page to ask for that.

The main subject of this course is the **introduction of basic concepts used in the area of descriptive statistics** by applying them to examples from everyday life. Descriptive statistics is used to describe large data sets by a small set of characteristic numbers or by graphics.
This course introduces the most well-known **measures of location and measures of spread for discrete distributions**. All the important terms are explained in our list of short definitions (chap. 1.2). To understand the course content you need mathematical skills of, at maximum, GCSE-level (sum with fractions, percentage calculation, calculations with powers of numbers, notation of sums and products).

On the following pages you are administered homoeopathic doses of statistics. Please test their effectiveness immediately after taking them: experiment on yourself by working through the examples. We hope you'll get really interested in the subject and will register; you'll get tutoring for nothing and the ID for free. This means you can ask for help on the course content and environment and get feedback on your solutions of the exercises sent in.

Please familiarise yourself with the navigation elements appearing on all pages by reading through the next chapter. For a systematic approach to the course content, simply always click the ▶-icon located in the navigation bar at the bottom of each page. You may use the ⊛-icon located in the browser's navigation bar to scroll back one page.

TOC ⏮ ◀ ▶ ⏭ Tutor


1 Einführung - Netscape 6
Datei Bearbeiten Anzeigen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.drgst.de/STAT/1_0stat_kurs.html
Suchen

1 Einführung

Willkommen beim WAP-Statistik-Kurs!
Dieser Kurs ist insgesamt einem Versuchsballon nicht unähnlich. Als Teil eines sog. LEONARDO-Projektes namens *from e-learning to m-learning* der Europäischen Union soll getestet werden, in wieweit sich Geräte, die mindestens über die Fähigkeiten des **Smartphones ERICSSON R380s** verfügen, **und das Medium WAP zum mobilen Lernen** eignen.
Alle Inhalte unterliegen dem Urhebergesetz und dürfen nur mit ausdrücklicher Genehmigung des Autors weiterverwendet werden. Benutzen Sie dazu die Kontakt-Seite.

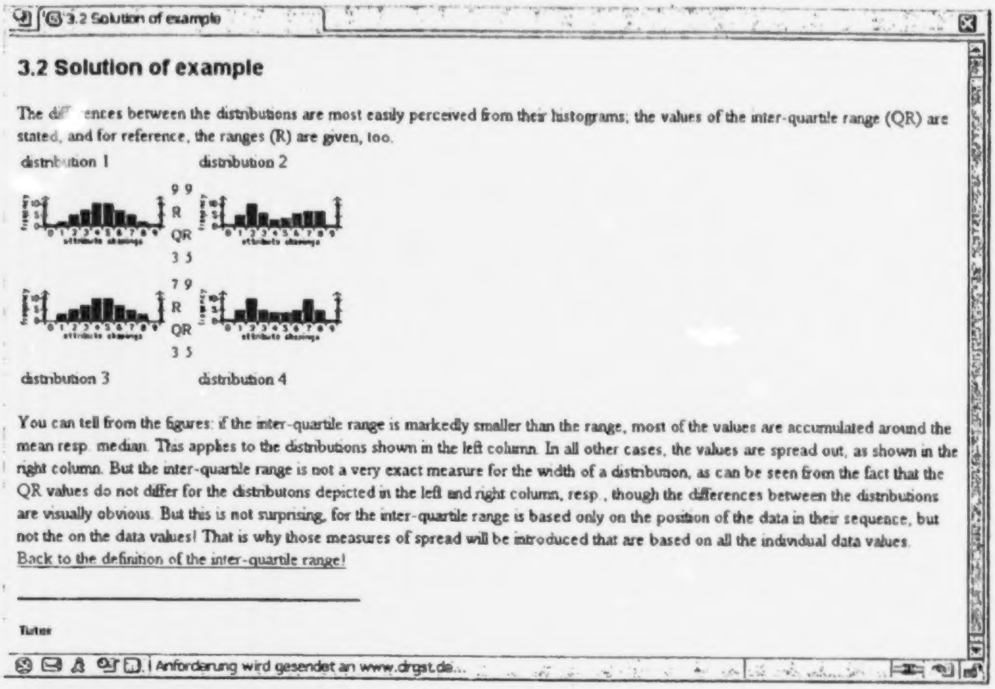
Der inhaltliche Schwerpunkt des Kurses liegt auf der durch Beispiele aus dem Alltag motivierten **Vorstellung grundlegender Begriffe aus der sog. deskriptiven Statistik**. Diese Teildisziplin der Statistik dient dazu, große Datenmengen durch wenige, aber aussagekräftige Kennzahlen oder auch Graphiken zu beschreiben.
Der Kurs behandelt dabei die **bekanntesten der sog. Lage- und Streuungs-Maße von diskreten Verteilungen**. Alle in diesem Zusammenhang wichtigen Begriffe werden in unseren Kurzdefinitionen erläutert. Zum Verständnis des Kurs-Inhaltes brauchen Sie mathematische Kenntnisse auf maximal Mittelstufen-Niveau (Bruch-, Prozent- und Potenzrechnung, Notation von Summen und Produkten).

Auf den folgenden Seiten werden Ihnen also homöopathische Dosen Statistik verabreicht. Deren Wirksamkeit können Sie sofort nach Einnahme im Selbstversuch testen, indem Sie Ihr Wissen anhand von gelösten Beispielen testen. Wenn Sie so richtig einsteigen wollen, dann registrieren Sie sich doch; es kostet nichts und Sie können dann auch bei evtl. auftretenden Fragen die Leistungen eines Tutors in Anspruch nehmen. Außerdem bekommen Sie dann eine Rückmeldung zu bearbeiteten Übungsaufgaben.

Bitte machen Sie sich als nächstes mit den Navigationselementen vertraut. Zum systematischen Durcharbeiten des Kurses klicken Sie einfach immer auf das ▶-Symbol in der Navigations-Leiste am unteren Rand einer jeden Seite. Zum "Zurückblättern" können Sie auch das ⊛-Symbol in der Navigationsleiste des Browsers verwenden.

Inhalt ⏮ ◀ ▶ ⏭ Tutor

Introductory chapter of the course



3.2 Solution of example

The differences between the distributions are most easily perceived from their histograms; the values of the inter-quartile range (QR) are stated, and for reference, the ranges (R) are given, too.

distribution 1 distribution 2

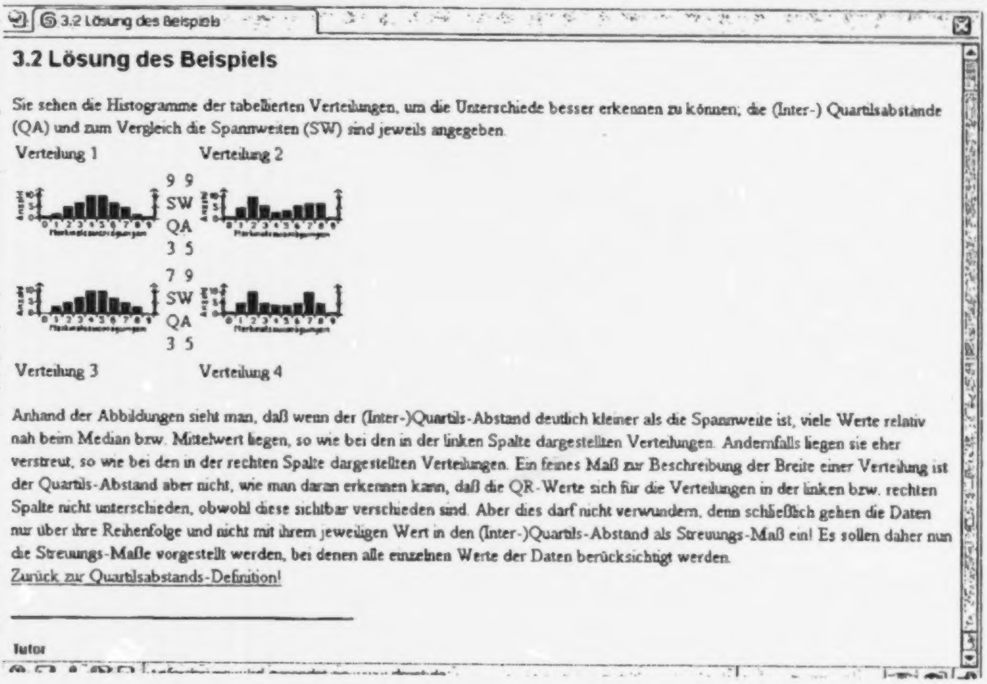
9 9
R
QR
3 5

7 9
R
QR
3 5

distribution 3 distribution 4

You can tell from the figures: if the inter-quartile range is markedly smaller than the range, most of the values are accumulated around the mean resp. median. This applies to the distributions shown in the left column. In all other cases, the values are spread out, as shown in the right column. But the inter-quartile range is not a very exact measure for the width of a distribution, as can be seen from the fact that the QR values do not differ for the distributons depicted in the left and right column, resp., though the differences between the distributions are visually obvious. But this is not surprising, for the inter-quartile range is based only on the position of the data in their sequence, but not the on the data values! That is why those measures of spread will be introduced that are based on all the individual data values.
Back to the definition of the inter-quartile range!

Tutor



3.2 Lösung des Beispiels

Sie sehen die Histogramme der tabellierten Verteilungen, um die Unterschiede besser erkennen zu können; die (Inter-) Quartilsabstände (QA) und zum Vergleich die Spannweiten (SW) sind jeweils angegeben.

Verteilung 1 Verteilung 2

9 9
SW
QA
3 5

7 9
SW
QA
3 5

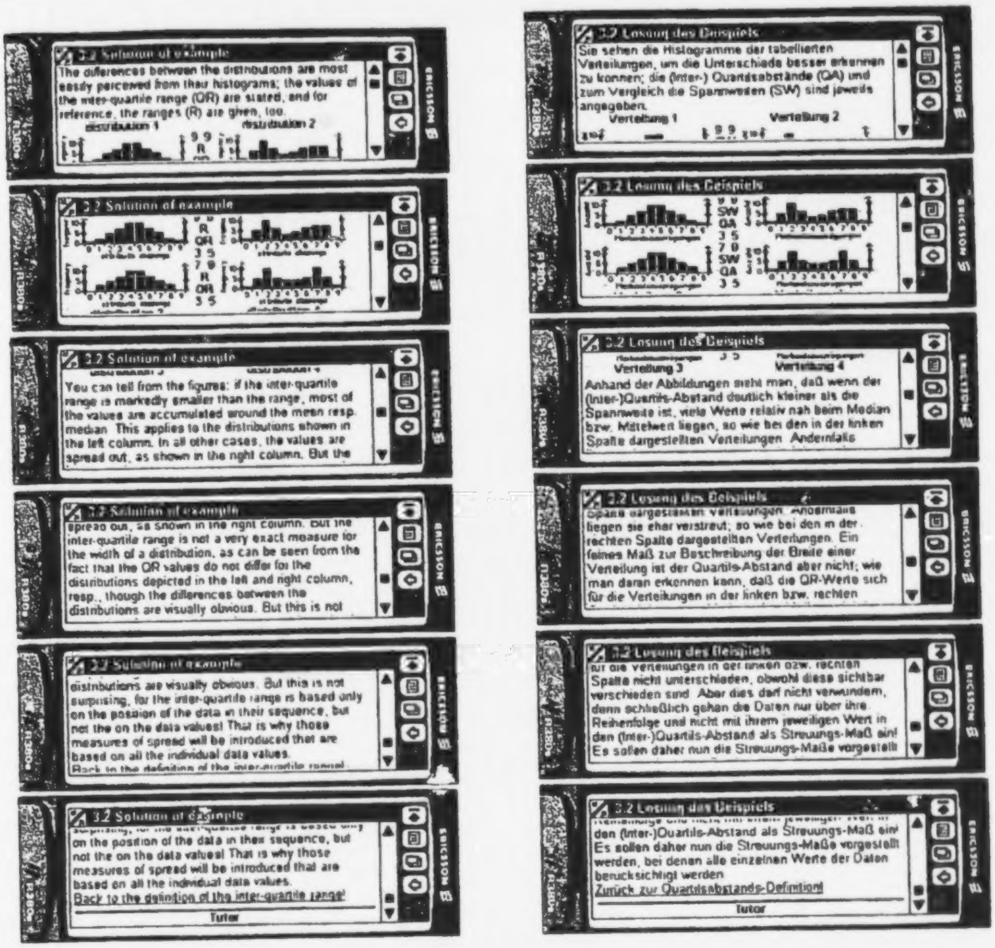
Verteilung 3 Verteilung 4

Anhand der Abbildungen sieht man, daß wenn der (Inter-)Quartils-Abstand deutlich kleiner als die Spannweite ist, viele Werte relativ nah beim Median bzw. Mittelwert liegen, so wie bei den in der linken Spalte dargestellten Verteilungen. Andernfalls liegen sie eher verstreut, so wie bei den in der rechten Spalte dargestellten Verteilungen. Ein feines Maß zur Beschreibung der Breite einer Verteilung ist der Quartils-Abstand aber nicht, wie man daran erkennen kann, daß die QR-Werte sich für die Verteilungen in der linken bzw. rechten Spalte nicht unterschieden, obwohl diese sichtbar verschieden sind. Aber dies darf nicht verwundern, denn schließlich gehen die Daten nur über ihre Reihenfolge und nicht mit ihrem jeweiligen Wert in den (Inter-)Quartils-Abstand als Streuungs-Maß ein! Es sollen daher nun die Streuungs-Maße vorgestellt werden, bei denen alle einzelnen Werte der Daten berücksichtigt werden.
Zurück zur Quartilsabstands-Definition!

Tutor

Page containing graphics, simply converted from original WML version depicted on the next page.

BEST COPY AVAILABLE



3.2 Solution of example

The differences between the distributions are most easily perceived from their histograms; the values of the inter-quartile range (QR) are stated, and for reference, the ranges (R) are given, too.

distribution 1 distribution 2

3.2 Solution of example

You can tell from the figures: if the inter-quartile range is markedly smaller than the range, most of the values are accumulated around the mean resp. median. This applies to the distributions shown in the left column. In all other cases, the values are spread out, as shown in the right column. But the inter-quartile range is not a very exact measure for the width of a distribution, as can be seen from the fact that the QR values do not differ for the distributions depicted in the left and right column, resp., though the differences between the distributions are visually obvious. But this is not surprising, for the inter-quartile range is based only on the position of the data in their sequence, but not the on the data values! That is why those measures of spread will be introduced that are based on all the individual data values.

Back to the definition of the inter-quartile range!

3.2 Lösung des Beispiels

Sie sehen die Histogramme der tabellierten Verteilungen, um die Unterschiede besser erkennen zu können; die (Inter-) Quartilsabstände (QA) und zum Vergleich die Spannweiten (SW) sind jeweils angegeben.

Verteilung 1 Verteilung 2

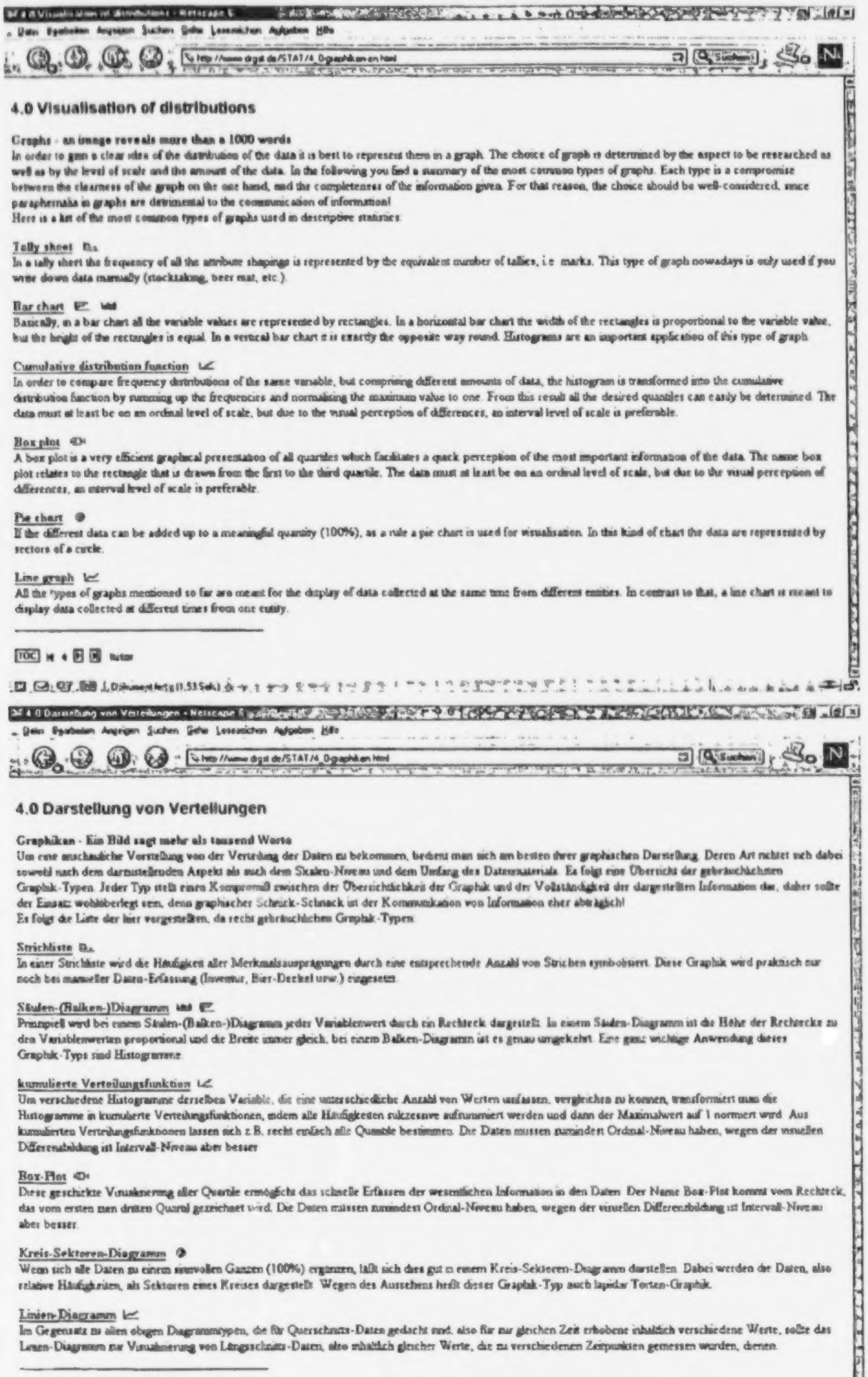
Verteilung 3 Verteilung 4

Anhand der Abbildungen sieht man, daß wenn der (Inter-)Quartils-Abstand deutlich kleiner als die Spannweite ist, viele Werte relativ nah beim Median bzw. Mittelwert liegen, so wie bei den in der linken Spalte dargestellten Verteilungen. Andernfalls liegen sie eher verstreut, so wie bei den in der rechten Spalte dargestellten Verteilungen. Ein feines Maß zur Beschreibung der Breite einer Verteilung ist der Quartils-Abstand aber nicht; wie man daran erkennen kann, daß die QR-Werte sich für die Verteilungen in der linken bzw. rechten Spalte nicht unterschieden, obwohl diese sichtbar verschieden sind. Aber dies darf nicht verwundern, denn schließlich gehen die Daten nur über ihre Reihenfolge und nicht mit ihrem jeweiligen Wert in den (Inter-)Quartils-Abstand als Streuungs-Maß ein! Es sollen daher nun die Streuungs-Maße vorgestellt werden, bei denen alle einzelnen Werte der Daten berücksichtigt werden.

Zurück zur Quartilsabstands-Definition!

WML (WAP) version of the chapter on the inter-quartile range, the HTML version of which was shown on the previous page

BEST COPY AVAILABLE


4.0 Visualisation of distributions - Netscape 6
Suchen
TOC
Tutor
4.0 Darstellung von Verteilungen - Netscape 6
Suchen
Inhalt
Tutor

4.0 Visualisation of distributions

Graphs - an image reveals more than a 1000 words
In order to gain a clear idea of the distribution of the data it is best to represent them in a graph. The choice of graph is determined by the aspect to be researched as well as by the level of scale and the amount of the data. In the following you find a summary of the most common types of graphs. Each type is a compromise between the clearness of the graph on the one hand, and the completeness of the information given. For that reason, the choice should be well-considered, since paraphernalia in graphs are detrimental to the communication of information!
Here is a list of the most common types of graphs used in descriptive statistics.

Tally sheet
In a tally sheet the frequency of all the attribute shapings is represented by the equivalent number of tallies, i.e. marks. This type of graph nowadays is only used if you write down data manually (stocktaking, beer mat, etc.).

Bar chart
Basically, in a bar chart all the variable values are represented by rectangles. In a horizontal bar chart the width of the rectangles is proportional to the variable value, but the height of the rectangles is equal. In a vertical bar chart it is exactly the opposite way round. Histograms are an important application of this type of graph.

Cumulative distribution function
In order to compare frequency distributions of the same variable, but comprising different amounts of data, the histogram is transformed into the cumulative distribution function by summing up the frequencies and normalising the maximum value to one. From this result all the desired quantiles can easily be determined. The data must at least be on an ordinal level of scale, but due to the visual perception of differences, an interval level of scale is preferable.

Box plot
A box plot is a very efficient graphical presentation of all quartiles which facilitates a quick perception of the most important information of the data. The name box plot relates to the rectangle that is drawn from the first to the third quartile. The data must at least be on an ordinal level of scale, but due to the visual perception of differences, an interval level of scale is preferable.

Pie chart
If the different data can be added up to a meaningful quantity (100%), as a rule a pie chart is used for visualisation. In this kind of chart the data are represented by sectors of a circle.

Line graph
All the types of graphs mentioned so far are meant for the display of data collected at the same time from different entities. In contrast to that, a line chart is meant to display data collected at different times from one entity.

4.0 Darstellung von Verteilungen

Graphiken - Ein Bild sagt mehr als tausend Worte
Um eine anschauliche Vorstellung von der Verteilung der Daten zu bekommen, bedient man sich am besten ihrer graphischen Darstellung. Deren Art richtet sich dabei sowohl nach dem darzustellenden Aspekt als auch dem Skalen-Niveau und dem Umfang des Datenmaterials. Es folgt eine Übersicht der gebräuchlichsten Graphik-Typen. Jeder Typ stellt einen Kompromiß zwischen der Übersichtlichkeit der Graphik und der Vollständigkeit der dargestellten Information dar, daher sollte der Einsatz wohlüberlegt sein, denn graphischer Schnick-Schnack ist der Kommunikation von Information eher abträglich!
Es folgt die Liste der hier vorgestellten, da recht gebräuchlichen Graphik-Typen.

Strichliste
In einer Strichliste wird die Häufigkeit aller Merkmalsausprägungen durch eine entsprechende Anzahl von Strichen symbolisiert. Diese Graphik wird praktisch nur noch bei manueller Daten-Erfassung (Inventur, Bier-Deckel usw.) eingesetzt.

Säulen-(Balken-)Diagramm
Prinzipiell wird bei einem Säulen-(Balken-)Diagramm jeder Variablenwert durch ein Rechteck dargestellt. In einem Säulen-Diagramm ist die Höhe der Rechtecke zu den Variablenwerten proportional und die Breite immer gleich, bei einem Balken-Diagramm ist es genau umgekehrt. Eine ganz wichtige Anwendung dieses Graphik-Typs sind Histogramme.

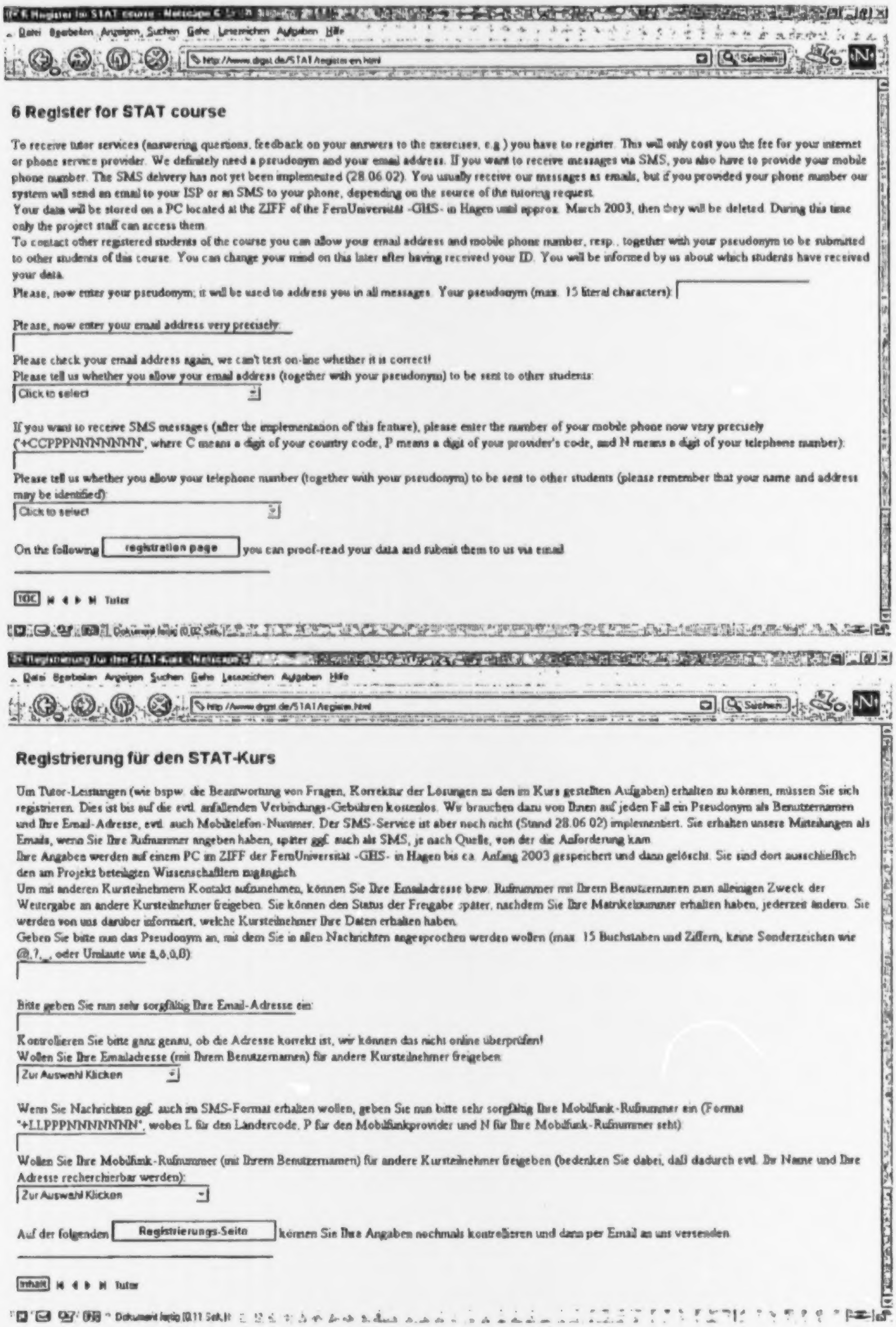
kumulierte Verteilungsfunktion
Um verschiedene Histogramme derselben Variable, die eine unterschiedliche Anzahl von Werten umfassen, vergleichen zu können, transformiert man die Histogramme in kumulierte Verteilungsfunktionen, indem alle Häufigkeiten sukzessive aufsummiert werden und dann der Maximalwert auf 1 normiert wird. Aus kumulierten Verteilungsfunktionen lassen sich z.B. recht einfach alle Quantile bestimmen. Die Daten müssen zumindest Ordinal-Niveau haben, wegen der visuellen Differenzbildung ist Intervall-Niveau aber besser.

Box-Plot
Diese geschickte Visualisierung aller Quartile ermöglicht das schnelle Erfassen der wesentlichen Information in den Daten. Der Name Box-Plot kommt vom Rechteck, das vom ersten zum dritten Quartil gezeichnet wird. Die Daten müssen zumindest Ordinal-Niveau haben, wegen der visuellen Differenzbildung ist Intervall-Niveau aber besser.

Kreis-Sektoren-Diagramm
Wenn sich alle Daten zu einem sinnvollen Ganzen (100%) ergänzen, läßt sich dies gut in einem Kreis-Sektoren-Diagramm darstellen. Dabei werden die Daten, also relative Häufigkeiten, als Sektoren eines Kreises dargestellt. Wegen des Aussehens heißt dieser Graphik-Typ auch lapidar Torten-Graphik.

Linien-Diagramm
Im Gegensatz zu allen obigen Diagrammtypen, die für Querschnitts-Daten gedacht sind, also für zur gleichen Zeit erhobene inhaltlich verschiedene Werte, sollte das Linien-Diagramm zur Visualisierung von Längsschnitts-Daten, also inhaltlich gleicher Werte, die zu verschiedenen Zeitpunkten gemessen wurden, dienen.

Beginning of chapter on visualisation in HTML


Datei Bearbeiten Ansehen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.digst.de/STAT/Register-en.html
Suchen

6 Register for STAT course

To receive tutor services (answering questions, feedback on your answers to the exercises, e.g.) you have to register. This will only cost you the fee for your internet or phone service provider. We definitely need a pseudonym and your email address. If you want to receive messages via SMS, you also have to provide your mobile phone number. The SMS delivery has not yet been implemented (28.06.02). You usually receive our messages as emails, but if you provided your phone number our system will send an email to your ISP or an SMS to your phone, depending on the source of the tutoring request.
Your data will be stored on a PC located at the ZIFF of the FernUniversität -GHS- in Hagen until approx. March 2003, then they will be deleted. During this time only the project staff can access them.
To contact other registered students of the course you can allow your email address and mobile phone number, resp., together with your pseudonym to be submitted to other students of this course. You can change your mind on this later after having received your ID. You will be informed by us about which students have received your data.
Please, now enter your pseudonym; it will be used to address you in all messages. Your pseudonym (max. 15 literal characters):

Please, now enter your email address very precisely:

Please check your email address again, we can't test on-line whether it is correct!
Please tell us whether you allow your email address (together with your pseudonym) to be sent to other students:
Click to select

If you want to receive SMS messages (after the implementation of this feature), please enter the number of your mobile phone now very precisely ('+CCPPPNNNNNNN', where C means a digit of your country code, P means a digit of your provider's code, and N means a digit of your telephone number):

Please tell us whether you allow your telephone number (together with your pseudonym) to be sent to other students (please remember that your name and address may be identified):
Click to select

On the following registration page you can proof-read your data and submit them to us via email

TOC
Tutor
Dokument: fertig (0,02 Sek.)
Registrierung für den STAT-Kurs - Netscape
Datei Bearbeiten Ansehen Suchen Gehe Lesezeichen Aufgaben Hilfe
http://www.digst.de/STAT/Register.html
Suchen

Registrierung für den STAT-Kurs

Um Tutor-Leistungen (wie bspw. die Beantwortung von Fragen, Korrektur der Lösungen zu den im Kurs gestellten Aufgaben) erhalten zu können, müssen Sie sich registrieren. Dies ist bis auf die evtl. anfallenden Verbindungs-Gebühren kostenlos. Wir brauchen dazu von Ihnen auf jeden Fall ein Pseudonym als Benutzernamen und Ihre Email-Adresse, evtl. auch Mobiltelefon-Nummer. Der SMS-Service ist aber noch nicht (Stand 28.06.02) implementiert. Sie erhalten unsere Mitteilungen als Emails, wenn Sie Ihre Rufnummer angeben haben, später ggf. auch als SMS, je nach Quelle, von der die Anforderung kam.
Ihre Angaben werden auf einem PC im ZIFF der FernUniversität -GHS- in Hagen bis ca. Anfang 2003 gespeichert und dann gelöscht. Sie sind dort ausschließlich den am Projekt beteiligten Wissenschaftlern zugänglich.
Um mit anderen Kursteilnehmern Kontakt aufzunehmen, können Sie Ihre Emailadresse bzw. Rufnummer mit Ihrem Benutzernamen zum alleinigen Zweck der Weitergabe an andere Kursteilnehmer freigeben. Sie können den Status der Freigabe später, nachdem Sie Ihre Matrikelnummer erhalten haben, jederzeit ändern. Sie werden von uns darüber informiert, welche Kursteilnehmer Ihre Daten erhalten haben.
Geben Sie bitte nun das Pseudonym an, mit dem Sie in allen Nachrichten angesprochen werden wollen (max. 15 Buchstaben und Ziffern, keine Sonderzeichen wie @,?,_, oder Umlaute wie ä,ö,ü,ß):

Bitte geben Sie nun sehr sorgfältig Ihre Email-Adresse ein:

Kontrollieren Sie bitte ganz genau, ob die Adresse korrekt ist, wir können das nicht online überprüfen!
Wollen Sie Ihre Emailadresse (mit Ihrem Benutzernamen) für andere Kursteilnehmer freigeben:
Zur Auswahl Klicken

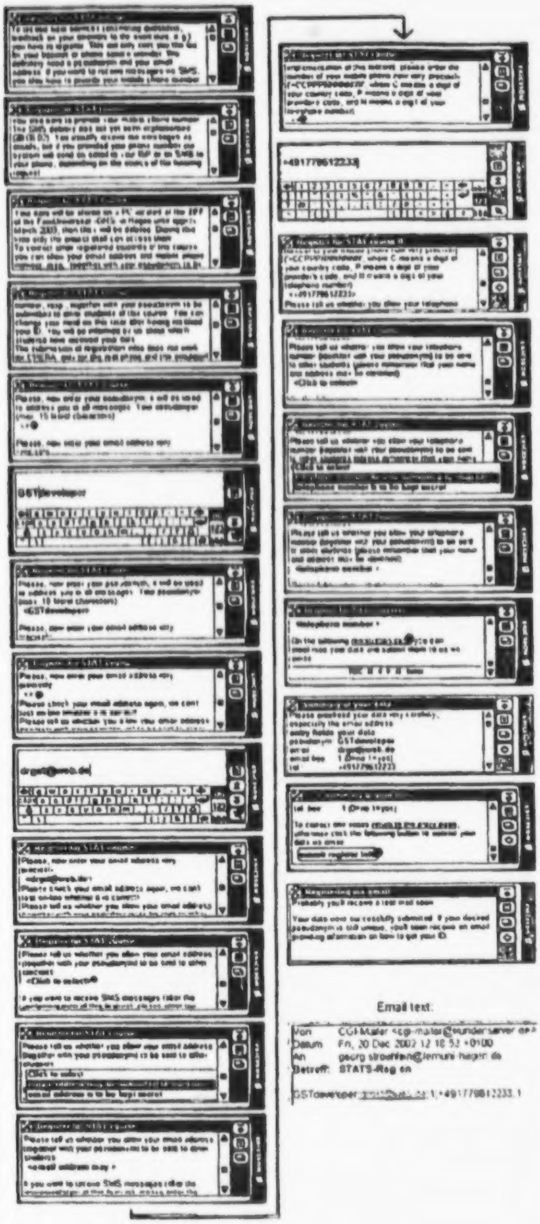
Wenn Sie Nachrichten ggf. auch im SMS-Format erhalten wollen, geben Sie nun bitte sehr sorgfältig Ihre Mobilfunk-Rufnummer ein (Format "+LLPPPNNNNNNN", wobei L für den Ländercode, P für den Mobilfunkprovider und N für Ihre Mobilfunk-Rufnummer steht):

Wollen Sie Ihre Mobilfunk-Rufnummer (mit Ihrem Benutzernamen) für andere Kursteilnehmer freigeben (bedenken Sie dabei, daß dadurch evtl. Ihr Name und Ihre Adresse recherchierbar werden):
Zur Auswahl Klicken

Auf der folgenden Registrierungs-Seite können Sie Ihre Angaben nochmals kontrollieren und dann per Email an uns versenden

Registration page of the course in HTML

BEST COPY AVAILABLE



Email text:

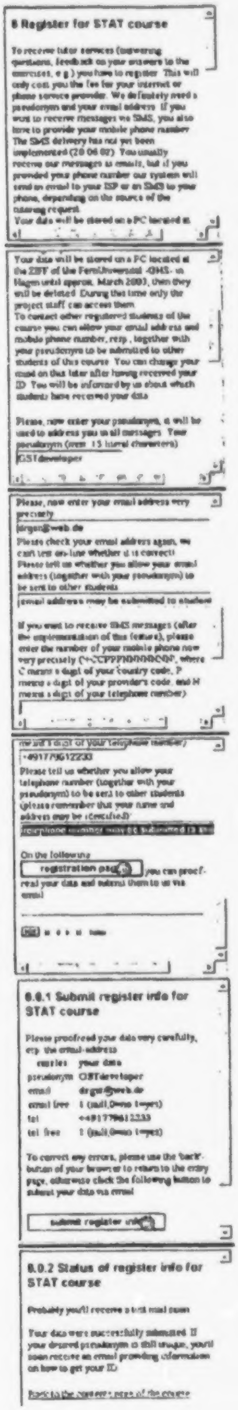
Von CGI-Mailer <cgi-mailer@[illegible]

Datum Fri, 20 Dec 2002 12:18:53 +0100

An georg.stroehlein@fernuni-hagen.de

Betreff: STATS-Reg on

GSTdeveloper [illegible] 1,+491779612233,1



8 Register for STAT course

To receive tutor services (answering questions, feedback on your answers to the exercises, e.g.) you have to register. This will only cost you the fee for your internet or phone service provider. We definitely need a pseudonym and your email address. If you want to receive messages via SMS, you also have to provide your mobile phone number. The SMS delivery has not yet been implemented (20.06.02). You usually receive our messages as emails, but if you provided your phone number our system will send an email to your ISP or an SMS to your phone, depending on the source of the tutoring request.

Your data will be stored on a PC located at the ZIFF of the FernUniversität -GHS- in Hagen until approx. March 2003, then they will be deleted. During this time only the project staff can access them.

To contact other registered students of the course you can allow your email address and mobile phone number, resp., together with your pseudonym to be submitted to other students of this course. You can change your mind on this later after having received your ID. You will be informed by us about which students have received your data.

Please, now enter your pseudonym, it will be used to address you in all messages. Your pseudonym (max. 15 literal characters)

GSTdeveloper

Please, now enter your email address very precisely

drgst@web.de

Please check your email address again, we can't test on-line whether it is correct!

Please tell us whether you allow your email address (together with your pseudonym) to be sent to other students

email address may be submitted to student

If you want to receive SMS messages (after the implementation of this feature), please enter the number of your mobile phone now very precisely ("+CCPPPNNNNNNN", where C means a digit of your country code, P means a digit of your provider's code, and N means a digit of your telephone number)

+491779612233

Please tell us whether you allow your telephone number (together with your pseudonym) to be sent to other students (please remember that your name and address may be identified)

telephone number may be submitted to stu

On the following registration page you can proofread your data and submit them to us via email

8.0.1 Submit register info for STAT course

Please proofread your data very carefully, esp. the email-address

entries	your data
pseudonym	GSTdeveloper
email	drgst@web.de
email free	1 (null,0=no 1=yes)
tel	+491779612233
tel free	1 (null,0=no 1=yes)

To correct any errors, please use the 'back'-button of your browser to return to the entry page, otherwise click the following button to submit your data via email

submit register info

8.0.2 Status of register info for STAT course

Probably you'll receive a test mail soon

Your data were successfully submitted. If your desired pseudonym is still unique, you'll soon receive an email providing information on how to get your ID

Back to the contents page of the course

Registration page of the course in WML **and on PDA in HTML**

6.2 Acknowledgements

Dr. Rudolf Schuemer is gratefully acknowledged for his defeatist remarks on my proposals for the content of the statistics course. He helped to minimise the danger that students believe in their standard text books.

And I'm deeply indebted to my sister Gerlind Ströhlein, M.A., for her outstanding performance in translating my sometimes clumsy German courseware into fluent English. Even the students of the German version will now benefit from her work.

Commendably many people have volunteered for the hands-on sessions. Hopefully, their detailed remarks will help to design better mobile devices and student support services in the future.

And last but not least I have to thank Dr. Helmut Fritsch a lot for not loosing his patience when hearing my "yes, Helmut, but..." or even "no, Helmut,...". We now prove that it is not only possible to keep a natural scientist and an arts scholar in friendly coexistence within the same floor but even allows the reports to benefit from the fruitful conversation.

6.3 Permissions

6.3.1 www.ebookmall.com

Thank you for contacting eBookMall. If you need any additional support after reading this message, please reply to this email and leave the previous message intact.

Hi, That sounds fine. Thanks very much for asking. If you have any other questions, just let me know.
Thanks, Bonnie Martin, eBookMall Customer Support
support@ebookmall.com   http://www.ebookmall.com/

Your question/comment was:
Dear ladies and gentlemen, I'd like to ask for your permission to use the page that appears when I open the URL .../choose-format/ in an official report of the 'from e-learning to m-learning' project of the EU. Of course, the source will be mentioned.
Best regards Georg Ströhlein

----

eBookMall Help Desk and Customer Support
http://www.ebookmall.com/helpdesk.htm
Toll Free 1-800-380-9040   Phone (530) 265-5200 -- Fax (530) 265-6556

6.3.2 www.thozie.de

Sehr geehrter Herr Ströhlein, sehr gerne. Kann man den Report lesen, wenn er fertig ist?
Mit freundlichen Grüssen, Thomas Ziegler
"Georg Ströhlein" <georg.stroehlein@fernuni-hagen.de> schrieb am 12.08.02 08:25:40:
> Sehr geehrter Herr Ziegler, ich würde gerne in einem offiziellen Report zum Projekt 'from e-learning to
> m-learning' im Rahmen eines EU-Projektes Ihre englisch-sprachigen Übersichten zu den verschiedenen
> Mark-up-Sprachen verwenden; selbstverständlich unter Angabe und der Quelle. Im Report müßte ich sie
> allerdings für den Druck etwas umgestalten, z.B. lange Tabellen teilen und mit Zwischenüberschriften
> versehen usw. Gestatten Sie mir das?
> Mit freundlichen Grüßen Dr. Georg Ströhlein
> FernUniversität -GHS- in Hagen, ZIFF Humpertstr. 11a D-58097 Hagen
> Tel.: 02331-987-2588 Fax: 02331-880637 Email: georg.stroehlein@fernuni-hagen.de

7 Literature

Arthur J. Cropley and Thomas N. Kahl, Distance education and distance learning: some psychological considerations, Distance Education 4(1), 27 (1983)

Helmut Fritsch, m-learning with smartphones: Student Usage of the WAP course , ZIFF final student report in the LEONARDO project 'from e-learning to m-learning'

Börje Holmberg, Theory and Practice of Distance Education, 2nd ed., Routledge, London (1995)

Börje Holmberg and Rudolf Schuemer, Lernen im Fernstudium, in F.E. Weinert and H. Mandl (Hrsg.), Serie I "Pädagogische Psychologie", Bd. 4, Psychologie der Erwachsenenbildung, Enzyklopädie der Psychologie, pp. 507-566, Hogrefe, Göttingen (1997)

Jo Bager, Überall am Netz: Unterwegs E-Mail, Web, WAP, Unified Messaging, Terminplaner und Adressbuch nutzen, c't 9/02, 92 (2002) [*Overview of mobile services via HTTP/WAP in Germany*]

Holger Bleich, Mobile Kostenfallen: Tarife für den Zugang zum Internet per Handy, c't 9/02, 100 (2002) [*Overview of tariffs for mobile internet access in Germany*]

Urs Mansmann, Handarbeit: Unterwegs ins Internet, c't 9/02, 104 (2002) [*Details of how to connect to the internet via HTTP/WAP in Germany*]

Tom's Hardware Guide, Drahtlos mit PDAs online gehen, http://www.de.tomshardware.com/mobile/02q3/020715/drahtlos-online-08.html (2002) [*Details of how to connect to the internet via HTTP/WAP in Germany*]

Hannes Rügheimer, Good Connections: Mit Handy und Notebook in jeder Lebenslage online? Der ultimative Überblick über alle Connectivity-Lösungen, connect 15/2001, 109 (2001) [*Details of how to connect to the internet via HTTP/WAP in Germany*]

Connectivity: AT-Befehle, connect 20/2001, 114 (2001) [*Details of how to adjust parameters via AT-scripting for HSCSD/GPRS connections in Germany*]

Hannes Rügheimer, Ein perfektes Paar: Per PDA und Daten-Handy E-Mails abrufen oder im Web surfen? Mit der richtigen Connectivity-Lösung können Sie diesen Tanz wagen., connect 24/2001, 125 (2001) [*Details of how to connect a PDA to the internet using a mobile phone in Germany*]

PRAX!S: Organizer&PC, Online mit GPRS, connect 6/2002, 68 (2002) [*Details of how to connect a PDA to the internet using a mobile phone, GPRS and a configuration tool in Germany*]

Christian Kirsch, Hürdenlauf: Mit PocketPC und PalmOS ins Netz, iX 6/2002, 54 (2002)

PART II, Helmut Fritsch: Student Usage

TABLE OF CONTENTS

1 INTRODUCTION 64

2 MOBILE LEARNING 64

2.1 Characteristics of mobile learning 65

2.2 Considerations about the courseware 65

2.3 Reduction of Redundancy 66

3 RESULTS OF THE EMPIRICAL STUDY 68

3.1 Section 1: social data 68

3.2 Section 2: User friendliness 69

3.3 Section 3: Didactic efficiency 71

3.4 Section 4: Technical feasibility 73

3.5 Section 5: Cost effectiveness 75

4 SUMMARY 76

1 Introduction

One of the impressions in urban areas throughout Europe is that you can see quite a lot of – especially young – people walking around or sitting somewhere, using their wireless devices for communication or just for fun, making use of games which are inbuilt or quickly downloaded.

The research question we had was to find out about the limits of such devices for learning, or better, for teaching purposes. The mobile learner, reviewing an exercise and communicating with fellow learners or tutors might use the device already at hand instead of purchasing a much more expensive palm top or even a notebook computer which in turn would be restricting ones range of activities possible during mobility-phases.

In Germany there is a TV spot about WAP where a businessman stands in front of a train station searching his handheld for looking up a nice restaurant nearby or a cheap hotel: Actually I never met someone standing in front of a train station and looking up the cheapest hotel nearby or the nicest restaurant by using WAP services. People in this situation would rather ask other people: So advertisement for such WAP services seems to be restricting the range of communication activities even more. Sometimes I have the vision that these devices are made for the normal handicapped people: refraining from direct communication.

After holding the device for the first time in my hand, I had the idea to ask my 16 year old son to teach me what I can do with it. I am not good in programming the video tape recording machine at home and when I see the kids with flying thumbs over the entry pad of their cellular phones to write SMS I wonder whether nature will adapt to technology in letting survive only the longest thumbs.

2 Mobile learning

If the sentence is true that human beings cannot help but learn, any technical gadget can be used for deliberately changing one's behaviour by intentionally collecting information, processing it and trying to validate the learned material in real life.

2.1 Characteristics of mobile learning

1) Learning takes place in the central nervous system of the learner; since the learner may also be "mobile" the assumption that learning may take place "on the move" is valid.

2) A smartphone like the Ericsson R380 is one possible instrument to promote and foster learning, but only
   - if nothing better is at hand
   - if there are no restrictions concerning payment of the bill
   - if the battery is loaded
   - if the provider is not "down" or does not have difficulties with WAP services
   - if you live in a region where cellular phones have a normal level of connectivity
   - if you are of normal visual capacity and not handicapped by having to use glasses

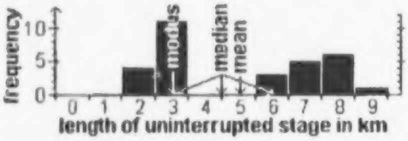
2.2 Considerations about the courseware

The development of course-material for teaching purposes in the framework of a university is different from the development of advertising material in a company – and also different from the aim of teaching literacy and numeracy basics to young people not engaged in education programs otherwise. Certain standards have to be met in order to integrate the material into the normal curriculum of a university. This brings us to one of the issues we encountered.

What actually is the curriculum we wanted to present? One of the modern and frustrating questions in the development of courses for normal university teaching, for distance teaching, for electronic teaching and certainly also for mobile teaching is the description of what exactly is offered in a certain set of terms, so that it makes sense to the end-user. This means in the light of accreditation of university courses that the set of descriptive terms – terminology of curriculum– should be included in the developmental work and likewise into the format of description in the meta tagging section of each HTML page or WML deck.

One of the difficulties in development of structured material for learning purposes is the inclusion of didactical and organizational **details**:

$$AD := \frac{1}{N}\sum_{i=1}^{N}\left|x_i - \bar{x}_{med}\right|$$



If you decide to present a course unit which is meant to be serious material for higher education you will have to insist on the possibility to **include graphics**.

Normally such graphics are used to condense procedures or result-aspects by graphical representation, which seems to be one of the general intellectual strategies to reduce complexity. Reduction of complexity is one of the most important aspects of scientific work.

2.3 Reduction of Redundancy

There is, when you look at the structural possibilities of the technology, a trend towards reduction of complexity of possible content. This can be very important for developers: Simply no space for redundancy, the need to tell directly what is important. When we all learned to use the software "Word" because the computer we had bought came with that software package, we learned -hopefully- to use shortcuts in order to speed up our typing and editing competencies. Then came "word for windows" and we all had been so happy that shortcuts still worked without using the "mouse". But we also learned that the possibilities offered were millions of alternatives to edit text. I think that the normal text-system user of such complex software like "Word" uses less than 10% of the in-built possibilities of the program. Then in the mid nineties we learned that HTML was less complex, but still powerful enough to represent all our editing procedures we used in Word - so we not only edited for printing and circulating printouts among colleagues and students but we also learned to edit pages in the world-wide-web. Now we are about to learn an even less complex system for use in all kinds of communication technology: WML, based on the language XML is said to be even less complex compared with HTML. And again the price for this reduction in possible complexity is less redundancy in communication. This may be helpful because **redundancy seems at the first glance to be something for poets, not for technocrats**. Communication theory, though, teaches us that redundancy in communication is what stands for individual differences, for additional flavour, representing the aspect of relation in each communicative act (Watzlawick, Beavin, Jackson: Human Communication). The problem here is now that the reduction of complexity has to be taken into consideration when dealing with technical systems which reduce redundancy to a certain lower standard.

There will be a notably lowest level of necessary redundancy also in mobile systems. Two aspects are important:

1. reduction of technical redundancy
2. increase of didactical redundancy in learning systems
   Especially the second item is of interest to the project focus .

The reduction of redundancy has been deplored as one of the necessary deficiencies of less complex presentations– speaking of the number of lines possible for argumentation in texts. This phenomenon necessary for texts on the small display of a smartphone is hard for the author of such teaching material and almost impossible to meet with standards of argumentation in other academic fields. But if, as compensation, there is the possibility to use graphics, much of the restrictions to textual redundancy can be counterbalanced.

When translating German texts into English, many people find at first sight that the same text will be much shorter in English than in German.

Whether there is a general rule to that and whether such German, longer texts are less precise or less complex should be an investigation for comparative linguistics. For us the necessity to reduce the length of texts because of the medium used has been irritating.

Our main problem, though, was the size of cache memory (32kb), which only allows the download of a little number of decks (small files fitting into the smartphone). Already when developing the course material this restriction had to be on our mind. So when you are used to develop a text, you write it down for your lecture and then just begin the lecture: you are prepared even for deviations.

Then you had to learn HTML, restricting you to the size of presentation into one page in order to avoid scrolling on the side of the learner. The next step looks like the presentation in power-point foils, which again will restrict you in available size of argumentation before each scenery changes. So most MS-PowerPoint representations will necessarily have the spoken word going along with them. When I read the description of WAP and the smartphone I was quite happy that such beautiful gadgets like MS-PowerPoint could be handled with this tiny tool.

During the lifetime of the project we encountered the difficulties with WAP in Germany- for several weeks: T-Online had severe problems to provide us with our WAP pages.

Now we found out that WAP is past. And this is o.k. with us, because WAP has made us work more than necessary for the course - we were looking for a transformation method how to transform our "normal" HTML into the handheld browser. Universities will not be able to provide the students with several different modes of presentation, it seems today that they are just about to accept the HTML as a standard for presenting content to their students – they simply don't care about technology behind. A couple of weeks ago we found out that there is a routine which can be inbuilt, to decode zipped HTML files into your PDA.

So the result of what I wanted to transmit is: Since WAP is "out", we are heading back to HTML. Let's try to refine this tool for educational purposes: there is a lot of work to do. For instance many fields of research are still to be dealt with, the whole range of didactical procedures, e.g.: At what points is communicative contact necessary? How can we foresee detours via hyperlinks, how do we trace the learners path (is this necessary at all)?

- Most important intellectual inventions have been brought about with **easy** media.
- A drawing in the sand for pure mathematics, chalk and a board for developing relativity-theory.
- **Redundancy** in the teaching process had the goal to **make learn.**
- „Offer the content in different ways for different students" (There is a lot of literature to aptitude-treatment interaction).
- WML decks offer less possibility for redundancy

We have to include metadata for the robots to find their way around, but also to include a meta-structure which enables the learner to find his/her way through the material offered: chapters, sub-chapters, references, glossaries, and all possibilities of moving back and forth without getting lost.

If the material is to meet the **prerequisites of distance education** you have to provide

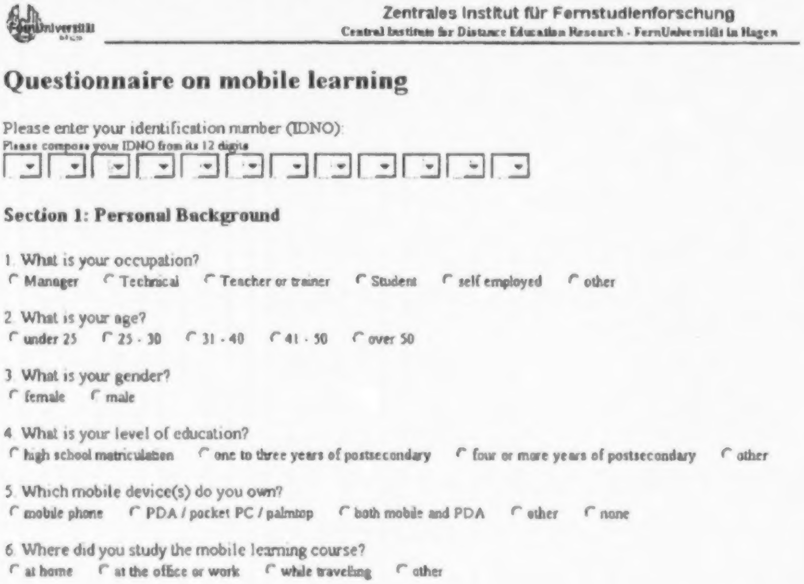
- possibilities to have contact as well with the institution as with fellow learners
- include possibilities of contact with a tutor or the author, and you will have to
- include assignments for self-testing or possibilities for (nearly) instant feedback and
- include a final test or assessment procedure leading to some kind of certificate!

Only by meeting such normal quality standards you will be recognized as being serious and the results of your teaching effort may result in accreditation in the university context: it is as easy as that.

3 Results of the empirical study

The questionnaire designed for evaluation of the project can be found at 'http://www.fernuni-hagen.de/ZIFF/frgb_mlearn-en.htm'. It has four sections which are briefly discussed here.

3.1 Section 1: social data



Zentrales Institut für Fernstudienforschung
Central Institute for Distance Education Research - FernUniversität in Hagen

Questionnaire on mobile learning

Please enter your identification number (IDNO):
Please compose your IDNO from its 12 digits

Section 1: Personal Background

1. What is your occupation?
○ Manager ○ Technical ○ Teacher or trainer ○ Student ○ self employed ○ other

2. What is your age?
○ under 25 ○ 25 - 30 ○ 31 - 40 ○ 41 - 50 ○ over 50

3. What is your gender?
○ female ○ male

4. What is your level of education?
○ high school matriculation ○ one to three years of postsecondary ○ four or more years of postsecondary ○ other

5. Which mobile device(s) do you own?
○ mobile phone ○ PDA / pocket PC / palmtop ○ both mobile and PDA ○ other ○ none

6. Where did you study the mobile learning course?
○ at home ○ at the office or work ○ while traveling ○ other

The distribution of social data had been as expected: Most of our clients (N=17) can be found in the category of "students" in the age group under 25. But we have been looking also for "students" of higher age - and found several ones who might be counted as further education students, interested in such new technological devices because they, as technical personnel or managers (N= 3) have to live up to their own expectations: to be forefront in experiences with such devices. The fourth item is somewhat tricky because we could not find one single student to "own" a smartphone of the kind we have been using, so we gave this device, the one we bought from project money, to these students and had them compare their experience with what they were used to: a normal WAP phone with an even smaller screen, or their PDA.

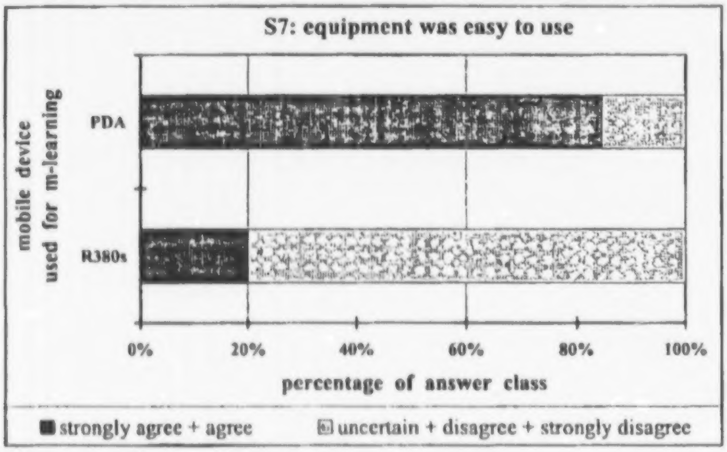
3.2 Section 2: User friendliness

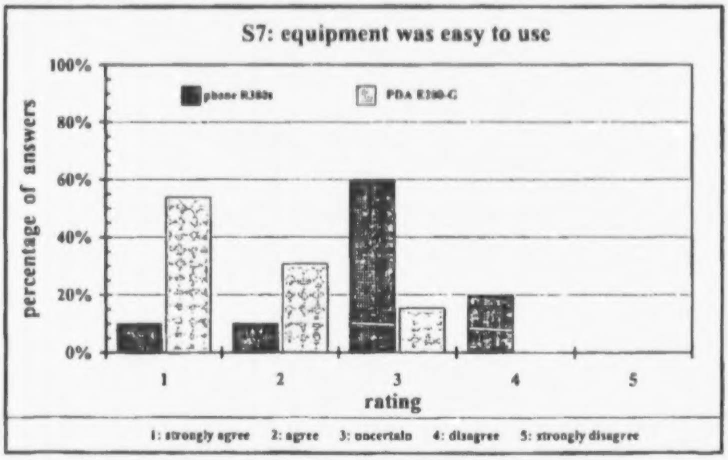
Section 2: User friendliness

Please read the following statements and then provide your level of agreement/disagreement using the scale:
1 = I strongly agree 2 = I agree 3 = I'm uncertain 4 = I disagree 5 = I strongly disagree

7. **It was easy to use the equipment in this mobile learning course.**
8. **This mobile learning experience was fun.**
9. **According to my experience I would take another mobile learning course if relevant to my learning needs.**
10. **I would recommend mobile learning as a method of study to others.**

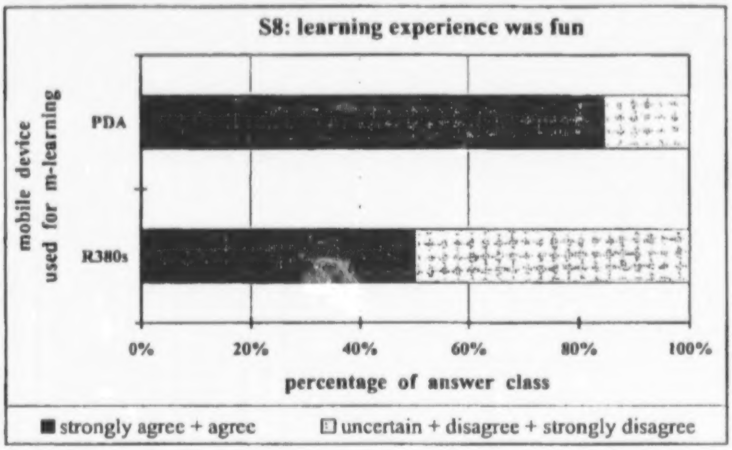
Here are the results. The students have had the experience with both devices.





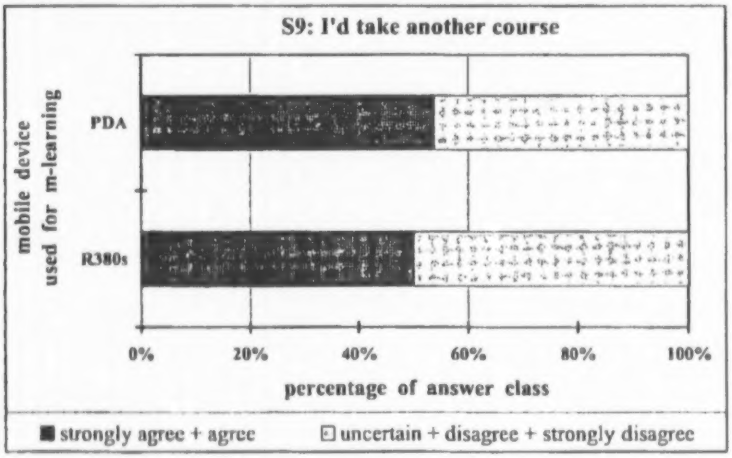
Polite, as our students are, most of them tick that they are uncertain about the ease to use the equipment but they already prefer the PDA, as can be seen from the graphical display of contrast rating scale.

Whether such an experience is something positive or not can directly be asked, the formulation of this question is meant to denote a positive atmosphere towards the questionnaire itself - it has the function to ease the answers, to set the stage for openness.

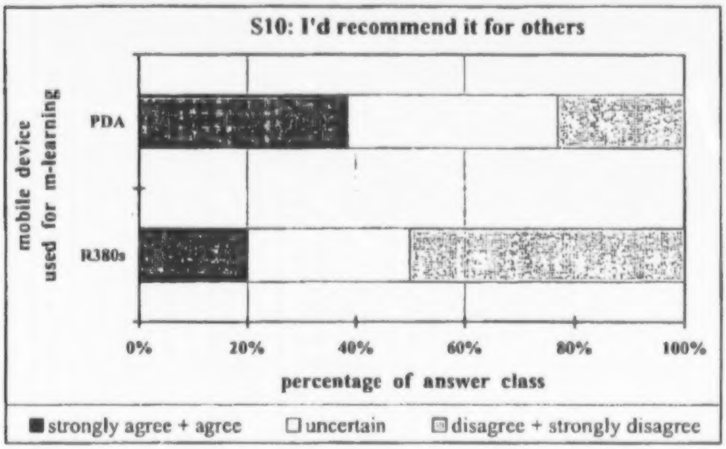


Only when there is this kind of openness we may expect students also to answer seriously, to not any longer try to give answers they expect us to hear (social desirability tendency).

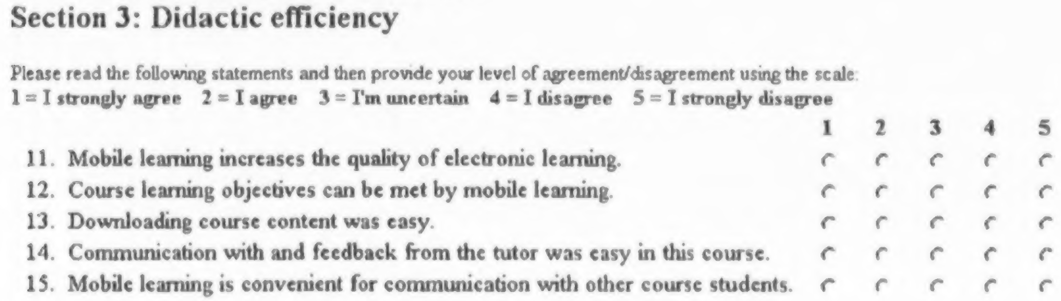
The answering students are in the midst of the experience; they are doubtful about their engagement with such devices and they do know about the questionnaire, now that they have come so far, it can be expected that they would not break the session and tell the interviewer to go away, they stick to their engagement and try to help in stating that they are willing to even take another course.



But let's have a closer look at this: There is a difference between your own behaviour in such a testing situation (you rather would take responsibility for your own behaviour than for recommending the same behaviour to others) and here we find the more important answers: Only 20% of our students would recommend the smartphone and mobile learning to others!



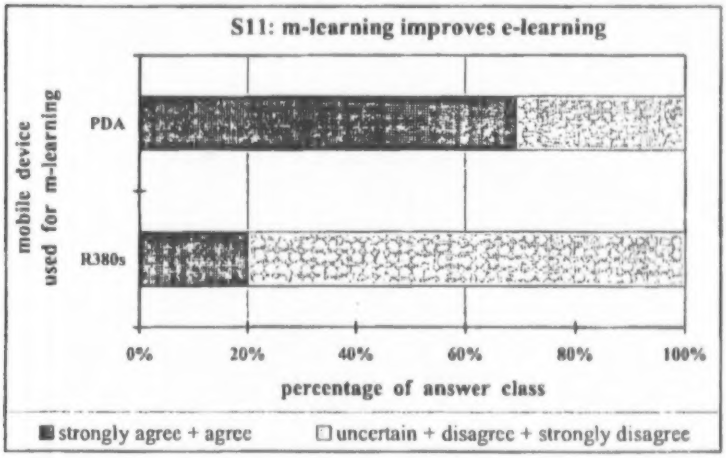
3.3 Section 3: Didactic efficiency



Section 3: Didactic efficiency

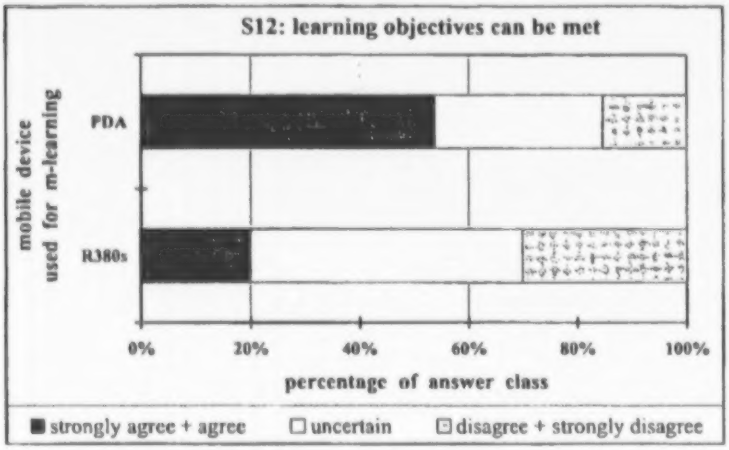
Please read the following statements and then provide your level of agreement/disagreement using the scale:
1 = I strongly agree 2 = I agree 3 = I'm uncertain 4 = I disagree 5 = I strongly disagree

	1	2	3	4	5
11. Mobile learning increases the quality of electronic learning.	○	○	○	○	○
12. Course learning objectives can be met by mobile learning.	○	○	○	○	○
13. Downloading course content was easy.	○	○	○	○	○
14. Communication with and feedback from the tutor was easy in this course.	○	○	○	○	○
15. Mobile learning is convenient for communication with other course students.	○	○	○	○	○

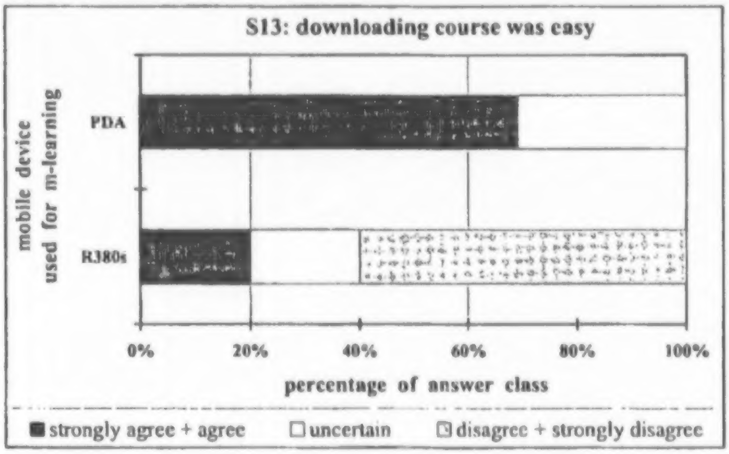


There is, without doubt, a strong tendency to accept mobile learning devices for e-learning.

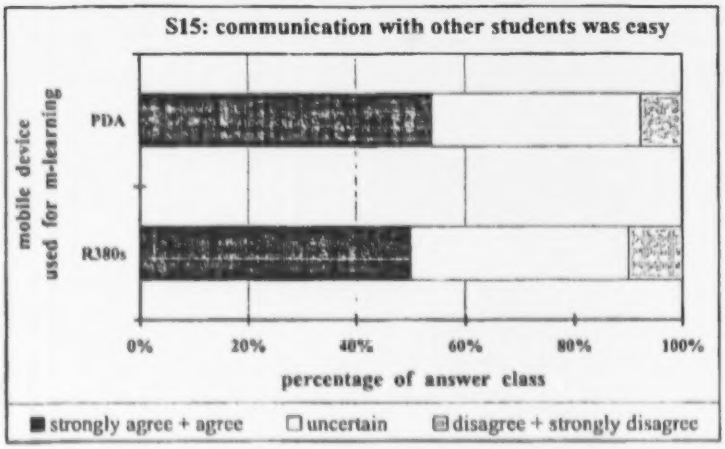
The next rather important result is the answer to the question whether the quality of e-learning can be increased by mobile devices: One of the key questions was whether students think that the learning objectives can be met.



Actually the difference between the two types of devices is responsible for the type of answers: While the PDA has a large storage capacity and you can download a complete course, the smartphone can only download a couple of pages at a time, so the question of ease when downloading is not really comparable.



The next aspect seems to be the strength of the smartphone!



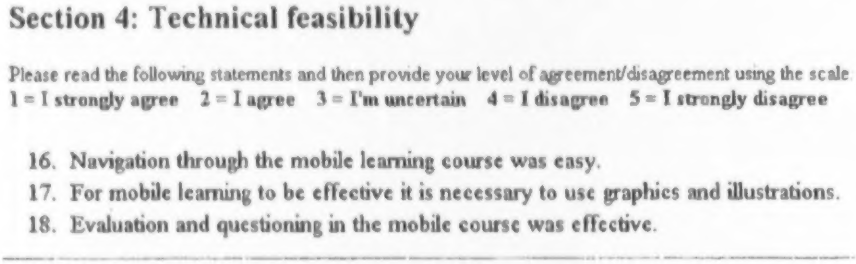
And when we know how important communication, the direct contact between student and tutor is , especially in distance education, we do appreciate this result. This holds true for both types of communication also in the next question- the communication among the student group.

3.4 Section 4: Technical feasibility

The three questions in this section give answers to the questions stemming from the structure of the course itself. a good course, suitable for distance education has to have not only the possibility for direct communication as shown in the section before but also has to have the possibility for easy navigation, has to include graphics as illustrations and finally to include also questions for self-evaluation or testing.

So it is about techniques of distance education not so much about technical aspects like voltage or weight.

In future questionnaires this aspect probably should be called "didactical techniques".

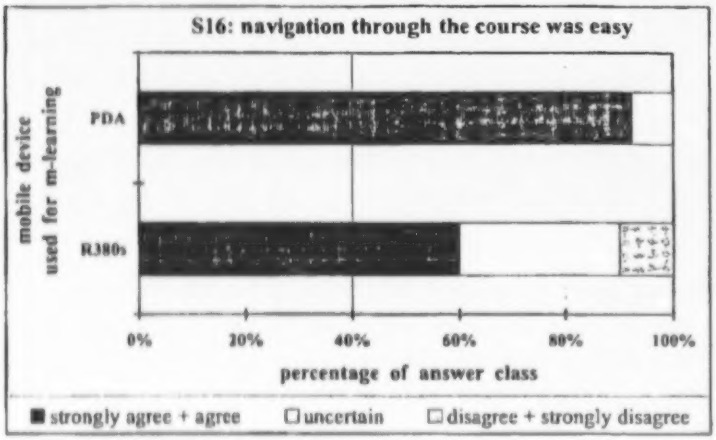


Section 4: Technical feasibility

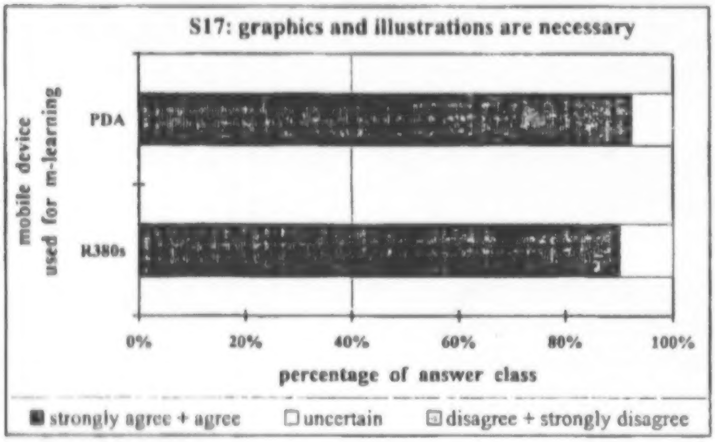
Please read the following statements and then provide your level of agreement/disagreement using the scale
1 = I strongly agree 2 = I agree 3 = I'm uncertain 4 = I disagree 5 = I strongly disagree

16. **Navigation through the mobile learning course was easy.**
17. **For mobile learning to be effective it is necessary to use graphics and illustrations.**
18. **Evaluation and questioning in the mobile course was effective.**

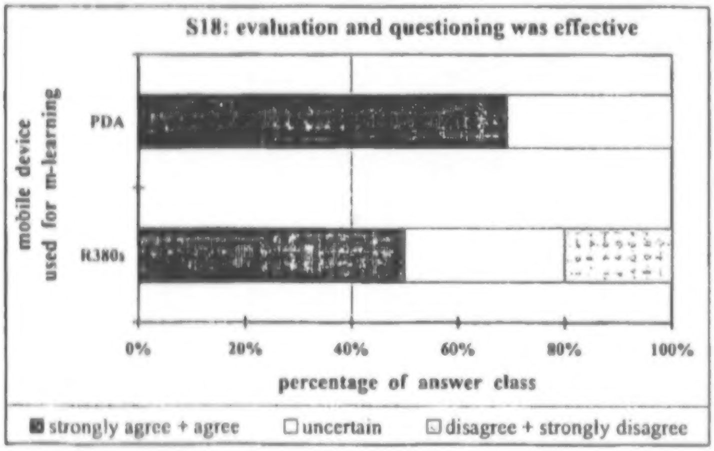
Having included a navigation bar on each screen - which most students are used to from other instances of electronic learning, the rating seems to be acceptable. Navigation was not the important problem for our students.



As has been pointed out in many occasions before, graphics and illustrations are felt to be necessary for such a course- and once these technical prerequisites are given there is no obstacle studying with such a device:



The same holds true with this aspect, crucial for didactics of distance education



3.5 Section 5: Cost effectiveness

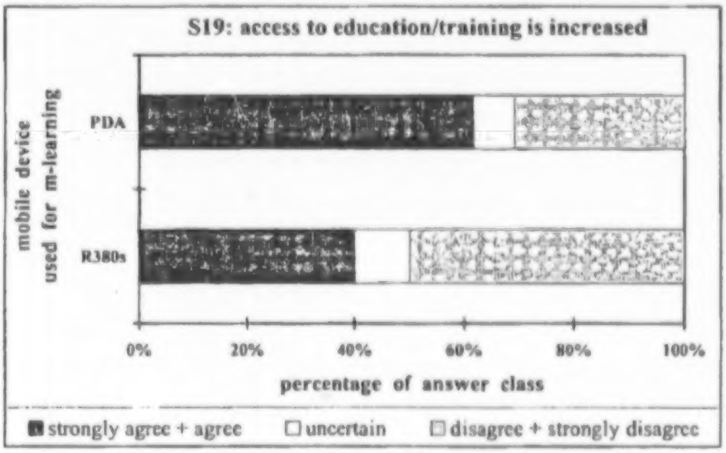
As we know from our technical report of the project, cost structures have been crucial to the commercial result of the device- not so much the fact that this device is more expensive to the customer in buying one but more so the fact that one never knows how long it will take to download and download again the material , due to broken connections always combined with cost on the side of the customer. GPRS, which the smartphone in our case could not use, would be a small remedy because the cost would be calculated by amount of bytes transferred and not be so much dependent on the quality of GSM connectivity. Anyhow, we asked our students for these aspects, too:

Section 5: Cost effectiveness

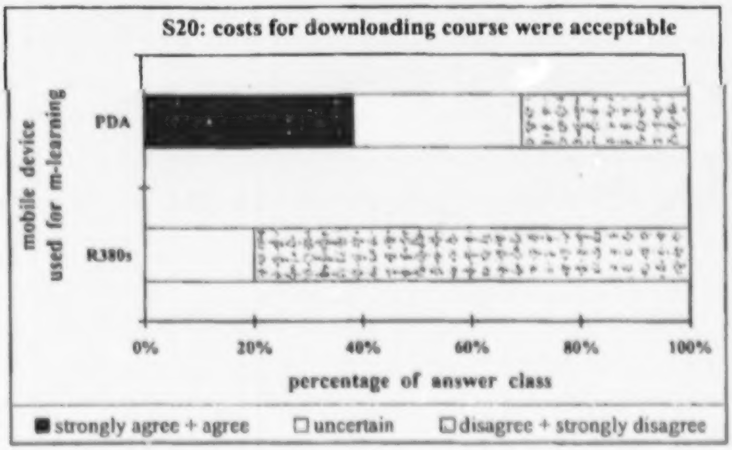
Please read the following statements and then provide your level of agreement/disagreement using the scale
1 = I strongly agree 2 = I agree 3 = I'm uncertain 4 = I disagree 5 = I strongly disagree

19. **Mobile learning increases access to education and training.**
20. **The cost of downloading the mobile course material was acceptable.**
21. **The cost of communicating in the mobile learning course with the tutor and other students was acceptable.**

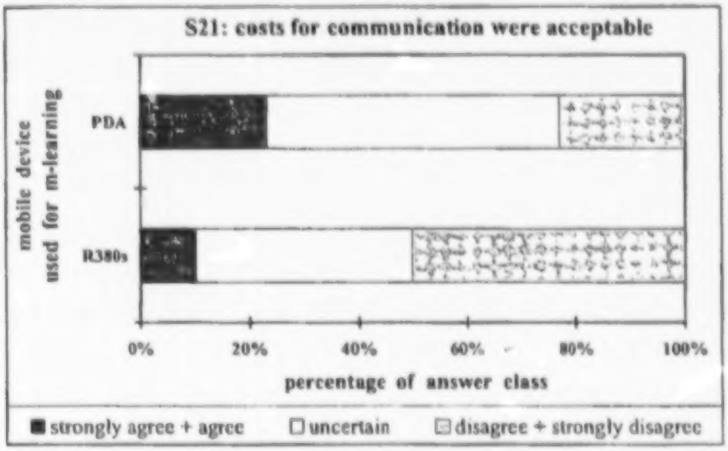
The general question, whether our students think that access to education and training might be increased, is a favourable one:



Another item on the list of crucial questions was acceptability of cost for the use of technology: Here we do have interesting answers: When it comes to the money to be invested, students also tick the more 'unpolite' answers.



Here we also find one of the crucial elements of distance education: there is a need to include the possibility of direct communication in electronic and even more so in mobile learning: but whenever this turns out to be too cost-intensive on the side of the student it will shut down all the other positive aspects of such offerings.



All in all we can say that according to our test group the smartphone R380s is from the cost aspect no eligible alternative in the scene of mobile learning equipment.

4 Summary

For the purpose of the Leonardo project a short academic course on some chapters in the field of descriptive statistics had been developed. This course could be presented in various technical formats. The result of this part of the project work was, that we feel the need for an automatic system on the server's side which delivers the content in the specific format the client requires in the HTTP headers, e.g.

Neither the course developer will be able to take care of all the technical prerequisites of different formats nor will be the end-user in a situation to fully install different formats on his available devices.

Students who worked through this course and have been asked to evaluate the different versions – WML, HTML and eBook – on different devices – R380s and PDAs – would not recommend the R380s for use in such a course.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

NOTICE

Reproduction Basis

☒ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").